D E C L A R A T I O N

In the matter of U.S. Patent Appln. Ser. No. 09/374,344 in the name of TOTO LTD.

I, KONNO Akio, of Kyowa Patent and Law Office, 2-3, Marunouchi 3-Chome, Chiyoda-Ku, Tokyo-To, Japan, declare and say:

that I am thoroughly conversant with both the Japanese and English languages; and,

that the attached document represents a true English translation of Japanese Patent Application No. 7-182020 filed on June 14, 1995.

I further declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code, and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

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Title of the Invention: ANTIFOGGING MEMBER, METHOD FOR PRODUCING THEREOF, AND METHOD FOR PREVENTING FOGGING OF MEMBER

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SPECIFICATION

1. TITLE OF THE INVENTION

Antifogging member, method for producing thereof, and method for preventing fogging of member

2. Claims

1. Antifogging member comprising a hydrophilic exposed surface and a means for sustaining the hydrophilic exposed surface.

2. The antifogging member of claim 1, comprising a substrate which forms a surface layer thereon having a hydrophilic exposed surface and a means for sustaining the hydrophilic exposed surface.

3. The antifogging member of either claim 1 or claim 2, wherein the means for sustaining the hydrophilic exposed surface is a photocatalyst.

4. The antifogging member of either claim 2 or claim 3, wherein a size of particles and void existing in the surface layer is 0.2 microns or less.

5. An antifogging member comprising a film made of a hydrophilic material containing a photocatalyst.

6. An antifogging member comprising a substrate and a surface layer made of a hydrophilic catalyst formed thereon.

7. An antifogging member comprising a substrate and a surface layer made of a hydrophilic photocatalyst and of a non-photocatalytic hydrophilic material formed thereon.

8. Antifogging member comprising a substrate and a surface layer made of a hydrophilic photocatalyst and of a non-photocatalytic hydrophilic material formed thereon, while an exposed surface is made of a non-photocatalytic hydrophilic material.

9. The antifogging member of either one of claims 6, 7, and 8, wherein an intermediate layer is sandwiched between the substrate and the surface layer.

10. The antifogging member of either one of claims 7, 8, and 9, wherein the non-photocatalytic hydrophilic material is a hydrophilicized photo-resistant resin.

11. The antifogging member of either one of claims 7, 8, and 9, wherein the non-photocatalytic hydrophilic material is an inorganic amorphous material.

12. The antifogging member of claim 10, wherein the hydrophilicized photo-resistant resin is a resin having Si-O bond or Si-N bond in backbone thereof.

13. The antifogging member of either claims 10 or claim 12, wherein the hydrophilicization is characterized by decomposition or oxidization of a portion of alkyl group or the like included in the resin comprising photo-resistant

ingredient at least at the backbone thereof, which group reacts under irradiation of ultraviolet light.

14. The antifogging member of either one of claims 2, 3, 4, and 6 through 13, wherein the surface layer contains an electron-acquiring metal.

15. The antifogging member of either one of claims 2, 3, 4, and 6 through 13, wherein the surface layer contains an anti-bacterial metal.

16. The antifogging member of a either one of claims 2, 3, 4 and 6 through 13, wherein the surface layer contain silver.

17. The antifogging member of claim 5, wherein the film contains an electron-acquiring metal.

18. The antifogging member of claim 5, wherein the film contains an anti-bacterial metal.

19. The antifogging member of claim 5, wherein the film contains silver.

20. The antifogging member of claim 9, wherein the substrate is a glass or a mirror containing an alkali-modified ingredient, and wherein the intermediate layer is a layer to prevent diffusion of the alkali-modified ingredient.

21. The antifogging member of claim 20, wherein the layer to prevent diffusion of the alkali-modified ingredient is a high purity silica layer.

22. The antifogging member of claim 20, wherein the layer to prevent diffusion of the alkali-modified ingredient is a layer containing an electron-acquiring metal.

22. The antifogging member of claim 9, wherein the surface layer comprises a hydrophilicized photo-resistant resin and a photocatalyst, and wherein the intermediate layer is a basecoat layer made of a resin.

24. The antifogging member of claim 5, wherein the film made of a hydrophilic material is a hydrophilicized photo-resistant resin.

25. The antifogging member of either claims 2, 3, 4, and 6 through 16, wherein a part of heat-generating means is added to the surface layer.

26. The antifogging member of either one of claims 5, 17, 18, 19, and 24, wherein a part of the heat-generating means is added to the film.

27. The antifogging member of either one of claims 2, 3, 4, 25, and 26, wherein a part of the heat-generating means is a tin oxide transparent electrode to which a means for impressing voltage is connected.

28. An antifogging member comprising plurality of materials laminated to each other, wherein the surface layer forming the uppermost surface of the laminated materials has a hydrophilic exposed surface and a means for sustaining the hydrophilicity, and wherein a gap is formed between at least a pair of the laminated materials.

29. An antifogging member comprising plurality of materials laminated to each other, wherein the surface layer forming the uppermost surface of the laminated materials has a hydrophilic exposed surface, a means for sustaining the hydrophilicity, and a part of heat-generating means, and wherein a gap is formed between at least a pair of the laminated materials.

30. An antifogging member comprising plurality of materials laminated to each other, wherein the surface layer forming the uppermost surface of the laminated materials has a hydrophilic exposed surface, a tin oxide transparent electrode, and wherein a gap is formed between at least a pair of the laminated materials, and wherein the electrode is connected with a means for impressing voltage thereto.

31. A member comprising a means for irradiating ultraviolet light located at periphery of the member claimed in either one of claims 1 through 30.

32. The member of claim 31, wherein a rim section is located to enclose the means for irradiating ultraviolet light.

33. A member comprising plurality of materials laminated to each other, wherein the surface layer forming the uppermost surface of the laminated materials has a hydrophilic exposed surface and a means for sustaining the hydrophilicity, and wherein a means for irradiating ultraviolet light is sandwiched between at least a pair of the laminated materials.

34. A member comprising a means for irradiating ultraviolet light against rear face of the member claimed in either one of claims 1 through 30.

35. The member of either one of claims 1 through 34, wherein the member is a mirror.

36. The member of either one of claims 1 through 34, wherein the member is a mirror in bathroom or in lavatory.

37. A method for manufacturing antifogging member comprising a hydrophilic film containing a photocatalyst, which method comprising the steps of: preparing a liquid by mixing a photocatalyst sol with a thermosetting resin having a photo-resistant ingredient in backbone thereof; heating to cure the liquid by pouring thereof into a mold; separating thus formed shape from the mold; then irradiating light containing ultraviolet light to the shape.

38. A method for manufacturing antifogging member comprising a hydrophilic film containing a photocatalyst and an anti-bacterial metal, which method comprising the steps

of: mixing a photocatalyst sol with a solution containing an antibacterial metal ion; preparing a liquid by mixing the solution of photocatalyst sol with a thermosetting resin having a photo-resistant ingredient in backbone thereof; heating to cure to liquid by pouring thereof into a mold; separating thus formed shape from the mold; then irradiating light containing ultraviolet light to the shape.

39. A method for manufacturing antifogging member comprising a hydrophilic film containing a photocatalyst and an anti-bacterial metal, which method comprising the steps of: mixing a photocatalyst sol with a solution containing an antibacterial metal ion; irradiating light containing ultraviolet light to the photocatalyst sol solution; preparing a liquid by mixing the solution of irradiated photocatalyst sol with a thermosetting resin having a photo-resistant ingredient in backbone thereof; heating to cure the liquid by pouring thereof into a mold; separating thus formed shape from the mold; then irradiating light containing ultraviolet light to the shape.

40. A method for manufacturing antifogging member comprising a hydrophilic film containing a photocatalyst and an anti-bacterial metal, which method comprising the steps of: preparing a liquid by mixing a photocatalyst sol with a thermosetting resin having a photo-resistant ingredient in backbone thereof; heating to cure the liquid by pouring thereof into a mold; separating thus formed shape from the mold; applying a solution containing an anti-bacterial metal ion onto the surface of the shape; then irradiating light

containing ultraviolet light to the shape.

41. A method for manufacturing antifogging member comprising a hydrophilic film containing a photocatalyst, which method comprising the steps of; applying photocatalytic particles onto the surface of an injection molding die; conducting injection molding within the injection molding die using a compound of thermoplastic resin having a photo-resistant ingredient in backbone thereof; then irradiating light containing ultraviolet light to thus molded shape.

42. A method for manufacturing antifogging member comprising a hydrophilic film containing a photocatalyst, which method comprising the steps of: preparing mixed particles by fixing an anti-bacterial metal to photocatalytic particles; applying the mixed particles onto the surface of an injection molding die; conducting injection molding within the injection molding die using a compound of thermoplastic resin having a photo-resistant ingredient in backbone thereof; then irradiating light containing ultraviolet light to thus molded shape.

43. A method for manufacturing antifogging member comprising a glass substrate and a surface layer made of a hydrophilic photocatalyst, which method comprising the steps of: applying a precursor of photocatalyst onto the surface of the glass substrate; then firing the applied glass substrate.

44. A method for manufacturing antifogging member comprising a glass substrate containing an alkali metal or an alkali earth metal, and a surface layer made of a hydrophilic photocatalyst, which method comprising the steps of: forming a glass layer containing no alkali metal nor alkali earth metal onto a glass substrate containing an alkali metal or an alkali earth metal; applying a precursor of photocatalyst onto the surface of the glass substrate; then firing the applied glass substrate.

45. A method for manufacturing antifogging member comprising a mirror, and a surface layer made of a hydrophilic photocatalyst, which method comprising the steps of: applying a precursor or photocatalyst onto the surface of a glass before fabricating the mirror; firing the applied glass; then applying silver onto rear face of the glass using the silver mirror reaction.

46. A method for manufacturing antifogging member comprising a mirror, and a surface layer made of a hydrophilic photocatalyst, which method comprising the steps of: applying a precursor of photocatalyst onto the surface of a glass before fabricating the mirror, firing the applied glass; applying silver onto rear face of the glass using the silver mirror reaction; then protecting thus formed silver mirror section using a resin composition and the like.

47. A method for manufacturing antifogging member comprising a mirror, and a surface layer made of a hydrophilic photocatalyst, which method comprising the steps

of: forming a glass layer containing no alkali metal nor alkali earth metal onto the surface of a glass before fabricating the mirror; applying a precursor of photocatalyst onto the surface of the glass layer; firing the applied glass; then applying silver onto rear face of the glass using the silver mirror reaction.

48. A method of manufacturing antifogging member comprising a mirror, and a surface layer made of a hydrophilic photocatalyst, which method comprising the steps of: forming a glass layer containing no alkali metal nor alkali earth metal onto a glass substrate before fabricating the mirror; applying a precursor of photocatalyst onto the surface of the glass layer; firing the applied glass; applying silver onto rear face of the glass using the silver mirror reaction; then protecting thus formed silver mirror section using a resin composition and the like.

49. A method for manufacturing antifogging member comprising a mirror, and a surface layer made of a hydrophilic photocatalyst, which method comprising the steps of: after fabricating the mirror, applying a precursor of photocatalyst onto the surface of the mirror; then firing the applied mirror.

50. A method for manufacturing antifogging member comprising a mirror, and a surface layer made of a hydrophilic photocatalyst, which method comprising the steps of: after fabricating the mirror, forming a glass layer containing no alkali metal nor alkali earth metal onto the

surface of the mirror; applying a precursor of photocatalyst onto the glass layer; then firing the applied mirror.

51. A method for manufacturing antifogging member comprising a glass substrate, and a surface layer made of a hydrophilic photocatalyst and an anti-bacterial metal, which method comprising the steps of: applying a precursor of photocatalyst onto the surface of the glass substrate; firing the applied glass substrate; applying a solution containing an anti-bacterial metal ion onto the surface of thus fired shape; then irradiating light including ultraviolet light to the shape.

52. A method for manufacturing antifogging member comprising a glass substrate, and a surface layer made of a hydrophilic photocatalyst and an anti-bacterial metal, which method comprising the steps of: forming a glass layer containing no alkali metal nor alkali earth metal onto the surface of the glass substrate; applying a precursor of photocatalyst onto the glass substrate; firing the applied glass layer; applying solution containing an anti-bacterial metal ion onto the surface of the layer of applied precursor of photocatalyst; then irradiating light including ultraviolet light to thus fired shape.

53. A method for manufacturing antifogging member comprising a mirror, and a surface layer made of a hydrophilic photocatalyst and an anti-bacterial metal, which method comprising the steps of: applying a precursor of photocatalyst onto the surface of a glass before fabricating

the mirror; firing the applied glass; applying a solution containing an anti-bacterial metal ion onto the surface of the fired shape; irradiating light including ultraviolet light to the shape; then fixing silver onto rear face of the shape using the silver mirror reaction.

54. A method for manufacturing antifogging member comprising a mirror, and a surface layer made of a hydrophilic photocatalyst and an anti-bacterial metal, which method comprising the steps of: applying a precursor of photocatalyst onto the surface of a glass before fabricating the mirror; firing the applied glass; applying a solution containing an anti-bacterial metal ion onto the surface of thus fired shape; irradiating light including ultraviolet light to the shape; fixing silver onto rear face of the shape using the silver mirror reaction; then protecting thus formed silver mirror section with a resin composition or the like.

55. A method for manufacturing antifogging member comprising a mirror, and a surface layer made of a hydrophilic photocatalyst and an anti-bacterial metal, which method comprising the steps of: applying a precursor of photocatalyst onto the surface of a glass before fabricating the mirror; firing the applied glass; fixing silver onto rear face of thus fired shape using the silver mirror reaction; applying a solution containing an anti-bacterial metal ion onto the surface of the shape; then irradiating light including ultraviolet light to the shape.

56. A method for manufacturing antifogging member comprising a mirror, and a surface layer made of a hydrophilic photocatalyst and anti-bacterial metal, which method comprising the steps of: applying a precursor of photocatalyst onto the surface of a glass before fabricating the mirror; firing the applied glass; fixing silver onto rear face of thus fired shape using the silver mirror reaction; protecting thus formed silver mirror section with a resin composition or the like; applying a solution containing an anti-bacterial metal ion onto the surface of the shape; then irradiating light including ultraviolet light to the shape.

57. A method for manufacturing antifogging member comprising a mirror, and a surface layer made of a hydrophilic photocatalyst and an anti-bacterial metal, which method comprising the steps of: after fabricating the mirror, applying a precursor of photocatalyst onto the surface of the mirror; firing the applied mirror; applying a solution containing an anti-bacterial metal ion onto the surface of the fired mirror; then irradiating light including ultraviolet light to the mirror.

58. A method for manufacturing antifogging member comprising a mirror, and a surface layer made of a hydrophilic photocatalyst and an anti-bacterial metal, which method comprising the steps of: forming a glass layer containing no alkali metal nor alkali earth metal onto the surface of a glass before fabricating the mirror; applying a precursor of photocatalyst onto the surface of the glass

layer; firing the applied glass; applying a solution containing an anti-bacterial metal ion onto the surface of thus fired shape; irradiating light including ultraviolet light to the shape; then fixing silver onto rear face of the shape using the silver mirror reaction.

59. A method for manufacturing antifogging member comprising a mirror, at a surface layer made of a hydrophilic photocatalyst and an anti-bacterial metal, which method comprising the steps of: forming a glass layer containing no alkali metal nor alkali earth metal onto the surface of a glass before fabricating the mirror; applying a precursor of photocatalyst onto the surface of the glass layer; firing the applied glass; applying a solution containing an anti-bacterial metal ion onto the surface of thus fired shape; irradiating light including ultraviolet light to the shape; fixing silver onto rear face of the shape using the silver mirror reaction; then protecting thus formed silver mirror section using a resin composition or the like.

60. A method for manufacturing antifogging member comprising a mirror, and a surface layer made of a hydrophilic photocatalyst and an anti-bacterial metal, which method comprising the steps of: forming a glass layer containing no alkali metal nor alkali earth metal onto the surface of a glass before fabricating the mirror; applying a precursor of photocatalyst onto the surface of the glass layer; firing the applied glass; fixing silver onto rear face of thus fired shape using the silver mirror reaction;

applying a solution containing an anti-bacterial metal ion onto the surface of the shape; then irradiating light including ultraviolet light to the shape.

61. A method for manufacturing antifogging member comprising a mirror, and a surface layer made of a hydrophilic photocatalyst and an anti-bacterial metal, which method comprising the steps of: forming a glass layer containing no alkali metal nor alkali earth metal onto the surface of a glass before fabricating the mirror; applying a precursor of photocatalyst onto the surface of the glass layer; firing the applied glass; fixing silver onto the rear face of thus fired shape using the silver mirror reaction; protecting thus formed silver mirror section using a resin composition or the like; applying a solution containing an anti-bacterial metal ion onto the surface of the shape; then irradiating light including ultraviolet light to the shape.

62. A method for manufacturing antifogging-member comprising a mirror, and a surface layer made of a hydrophilic photocatalyst and an anti-bacterial metal, which method comprising the steps of: after fabricating the mirror, forming a glass layer containing no alkali metal nor alkali earth metal onto the surface of the mirror; applying a precursor of photocatalyst onto the surface of the glass layer; firing the applied glass; applying a solution containing an anti-bacterial metal ion onto the surface of thus fired shape; then irradiating light including ultraviolet light to the shape.

63. The method for manufacturing antifogging member of

either one of claims 43 through 62, wherein the step for applying precursor of photocatalyst onto the surface of a substrate comprises the steps of: preparing an applying liquid by adding a diluent and a hydrolysis suppressor to alkoxide which is a precursor of photocatalyst; then applying the prepared liquid onto the surface of the glass substrate.

64. The method for manufacturing antifogging member of either one of claims 44, 47, 48, 50, 52, and 58 through 62, wherein the step for forming a glass layer containing no alkali metal nor alkali earth metal is a step for applying a precursor of silicon glass onto the surface of a glass substrate.

65. The method for manufacturing antifogging member of either one of claims 44, 47, 48, 50, 52, and 58 through 62, wherein the step for forming a glass layer containing no alkali metal nor alkali earth metal comprises the steps of: preparing an applying liquid by adding a diluent, water, and a hydrolysis suppressor to alkoxide which is a precursor of silicon glass; then applying thus prepared liquid onto the surface of a glass substrate.

66. The method for manufacturing antifogging member of claim 63, wherein the step for applying the applying liquid onto the surface of a substrate is conducted using dry air.

67. A method for manufacturing antifogging member comprising a substrate, and a surface layer made of a

hydrophilic photocatalyst and a hydrophilic material, which method comprising the steps of: preparing a liquid containing a photocatalyst sol and a photo-resistant thermosetting resin; applying thus prepared liquid onto the surface of the substrate; heating to cure the applied liquid; then irradiating light containing ultraviolet light to thus cured shape.

68. A method for manufacturing antifogging member comprising a substrate, and surface layer made of a hydrophilic photocatalyst and a hydrophilic material, which method comprising the steps of: forming a basecoat layer onto the surface of the substrate; applying a liquid containing a photocatalyst and a photo-resistant thermosetting resin onto the basecoat layer; heating to cure the applied liquid; then irradiating light containing ultraviolet light to thus cured shape.

69. A method for manufacturing antifogging member comprising a substrate, and a surface layer made of a hydrophilic photocatalyst, a hydrophilic material, and an anti-bacterial metal, which method comprising the steps of: mixing a photocatalyst sol and a solution containing an anti-bacterial metal ion; preparing a liquid by adding a photo-resistant thermosetting resin to the solution; applying the liquid onto the basecoat layer; heating to cure the applied liquid; then irradiating light containing ultraviolet light to the cured shape.

70. A method for manufacturing antifogging member

comprising a substrate, and a surface layer made of a hydrophilic photocatalyst, a hydrophilic material, and an anti-bacterial metal, which method comprising the steps of: forming a basecoat layer onto the surface of the substrate; mixing a photocatalyst sol and a solution containing an anti-bacterial metal ion; preparing a liquid by adding a photo-resistant thermosetting resin to the solution; applying the liquid onto the surface of the substrate; heating to cure the applied liquid; then irradiating light containing ultraviolet light to thus cured shape.

71. A method for manufacturing antifogging member comprising a substrate, and a surface layer made of a hydrophilic photocatalyst, a hydrophilic material, and an anti-bacterial metal, which method comprising the steps of: preparing a liquid containing a photocatalyst sol and a photo-resistant thermosetting resin; applying the liquid onto the surface of the substrate; heating to cure the applied liquid; applying a solution containing an anti-bacterial metal ion onto thus cured shape; then irradiating light containing ultraviolet light to the shape.

72. A method for manufacturing antifogging mamber comprising a substrate, and a surface layer made of a hydrophilic photocatalyst and hydrophilic material, which method comprising the steps of: forming a basecoat layer onto the surface of the substrate; applying a liquid containing a photocatalyst sol and a photo-resistant thermosetting resin onto the surface of the basecoat layer; heating to cure the applied liquid; applying a solution

containing an anti-bacterial metal ion onto thus cured shape; then irradiating light containing ultraviolet light to the shape.

73. A method for manufacturing antifogging member comprising a substrate, and a surface layer made of a hydrophilic photocatalyst and a hydrophilic material, which method comprising the steps of: after fabricating a mirror, applying a liquid containing a photocatalyst sol and a photo-resistant thermosetting resin onto the surface of the mirror; heating to cure the applied liquid; then irradiating light containing ultraviolet light to thus cured shape.

74. A method for manufacturing antifogging member comprising a substrate, and a surface layer consisting of a hydrophilic photocatalyst and a hydrophilic material, which method comprising the steps of: after fabricating a mirror, forming a basecoat layer onto the surface of the mirror; applying a liquid containing a photocatalyst sol and a photo-resistant thermosetting resin onto the basecoat layer; heating to cure the applied liquid; then irradiating light containing ultraviolet light to thus cured shape.

75. A method for manufacturing antifogging member comprising a substrate, and a surface layer consisting of a hydrophilic photocatalyst and a hydrophilic material, which method comprising the steps of: applying a liquid containing a photocatalyst sol and a photo-resistant thermosetting resin onto the surface of a glass before fabricating a mirror; heating to cure the applied liquid; irradiating

light containing ultraviolet light to thus cured shape; then fixing silver onto rear face of the shape using the silver mirror reaction.

76. A method for manufacturing antifogging member comprising a substrate, and a surface layer consisting of a hydrophilic photocatalyst and a hydrophilic material, which method comprising the steps of: forming a basecoat layer onto the surface of glass before fabricating a mirror; applying a liquid containing a photocatalyst sol and a photo-resistant thermosetting resin onto the basecoat layer; heating to cure the applied liquid; irradiating light containing ultraviolet light to thus cured shape; then fixing silver onto rear face of the shape using the silver mirror reaction.

77. A method for manufacturing antifogging member comprising a substrate, and a surface layer consisting of a hydrophilic photocatalyst and a hydrophilic material, which method comprising the steps of: applying a liquid containing a photocatalyst sol and a photo-resistant thermosetting resin onto the surface of a glass before fabricating a mirror; heating to cure the applied liquid; fixing silver onto rear face of thus cured shape using the silver mirror reaction; then irradiating light containing ultraviolet light to the shape.

78. A method for manufacturing antifogging member comprising a substrate, and a surface layer consisting of a hydrophilic photocatalyst and a hydrophilic material, which

method comprising the steps of: forming a basecoat layer onto the surface of a glass before fabricating a mirror; applying a liquid containing a photocatalyst sol and a photo-resistant thermosetting resin onto the basecoat layer; heating to cure the applied liquid; fixing silver onto rear face of thus cured shape using the silver mirror reaction; then irradiating light containing ultraviolet light to the shape.

79. A method for manufacturing antifogging member comprising a substrate, and a surface layer consisting of a hydrophilic photocatalyst, a hydrophilic material, and an anti-bacterial metal, which method comprising the steps of: after fabricating a mirror, mixing a photocatalyst sol with a solution containing anti-bacterial metal ion; adding a photo-resistant thermosetting resin to the mixed solution; applying thus prepared solution onto the surface of the mirror; heating to cure the applied liquid; then irradiating light containing ultraviolet light to thus cured shape.

80. A method for manufacturing antifogging member comprising a substrate, and a surface layer consisting of a hydrophilic photocatalyst, a hydrophilic material, and an anti-bacterial metal, which method comprising the steps of: after fabricating a mirror, forming a basecoat layer on the surface of the mirror; mixing a photocatalyst sol with a solution containing anti-bacterial metal ion; adding a photo-resistant thermosetting resin to the mixed solution; applying thus prepared liquid onto the basecoat layer; heating to cure the applied liquid; then irradiating light

containing ultraviolet light to thus cured shape.

81. A method for manufacturing antifogging member comprising a substrate, and a surface layer consisting of a hydrophilic photocatalyst, a hydrophilic material, and an anti-bacterial metal, which method comprising the steps of: after fabricating a mirror, applying a liquid containing a photocatalyst sol and a photo-resistant thermosetting resin onto the surface of the mirror; heating to cure the applied liquid; applying a solution containing an anti-bacterial metal ion onto thus cured shape; then irradiating light containing ultraviolet light to the shape.

82. A method for manufacturing antifogging member comprising a substrate, and a surface layer consisting of a hydrophilic photocatalyst, a hydrophilic material, and an anti-bacterial metal, which method comprising the steps of: after fabricating a mirror, forming a basecoat layer on the mirror; applying a liquid containing a photocatalyst sol and a photo-resistant thermosetting resin onto the basecoat layer; heating to cure to applied liquid; applying a solution containing an anti-bacterial metal ion onto thus cured shape; then irradiating light containing ultraviolet light to the shape.

83. A method for manufacturing antifogging member comprising a substrate, and a surface layer consisting of a hydrophilic photocatalyst, a hydrophilic material, and an anti-bacterial metal, which method comprising the steps of: mixing a photocatalyst sol with a solution containing an

anti-bacterial metal ion; adding a photo-resistant thermosetting resin to the mixture; applying thus prepared solution onto the surface of a glass before fabricating a mirror; heating to cure the applied solution; irradiating light containing ultraviolet light to the cured shape; then fixing silver onto rear face of the shape using the silver mirror reaction.

84. A method for manufacturing antifogging member comprising a substrate, and a surface layer consisting of a hydrophilic photocatalyst, a hydrophilic material, and an anti-bacterial metal, which method comprising the steps of: forming a basecoat layer on the surface of a glass before fabricating a mirror; mixing a photocatalyst sol with a solution containing an anti-bacterial metal ion; adding a photo-resistant thermosetting resin to the mixture; applying thus prepared solution onto the surface of the basecoat layer; heating to cure the applied solution; irradiating light containing ultraviolet light to thus cured shape; then fixing silver onto the rear face of the shape using the silver mirror reaction.

85. A method for manufacturing antifogging member comprising a substrate, and a surface layer consisting of a hydrophilic photocatalyst, a hydrophilic material, and an anti-bacterial metal, which method comprising the steps of; applying a liquid containing a photocatalyst sol and a photo-resistant thermosetting resin onto the surface of a glass before fabricating a mirror; heating to cure the applied liquid; applying a solution containing an

anti-bacterial metal ion onto thus cured shape; irradiating light containing ultraviolet light to the shape; then fixing silver onto rear face of the shape using the silver mirror reaction.

86. A method for manufacturing antifogging member comprising a substrate, and a surface layer consisting of a hydrophilic photocatalyst, a hydrophilic material, and an anti-bacterial metal, which method comprising the steps of: forming a basecoat layer onto the surface of a glass before fabricating a mirror; applying liquid containing a photocatalyst sol and a photo-resistant thermosetting resin onto the basecoat layer; heating to cure the applied liquid; applying a solution containing an anti-bacterial metal iron onto thus cured shape; irradiating light containing ultraviolet light to the shape; then fixing silver onto rear face of the shape using the silver mirror reaction.

87. A method for manufacturing antifogging member comprising a substrate, and a surface layer consisting of a hydrophilic photocatalyst, a hydrophilic material, and an anti-bacterial metal, which method comprising the steps of: applying a liquid containing a photocatalyst sol and a photo-resistant thermosetting resin onto the surface of a glass before fabricating a mirror; heating to cure the applied liquid; fixing silver onto rear face of thus cured shape using the silver mirror reaction; applying a solution containing an anti-bacterial metal ion onto the surface of the shape; then irradiating light containing ultraviolet light to the shape.

88. A method for manufacturing antifogging member comprising a substrate, and a surface layer consisting of a hydrophilic photocatalyst, a hydrophilic material, and an anti-bacterial metal, which method comprising the steps of: forming a basecoat layer onto the surface of a glass before fabricating a mirror; applying a liquid containing a photocatalyst sol and photo-resistant thermosetting resin onto the basecoat layer; heating to cure the applied liquid; fixing silver onto rear face of thus cured shape using the silver mirror reaction; applying a solution containing an anti-bacterial metal ion onto the shape; then irradiating light containing ultraviolet light to the shape.

89. The method for manufacturing antifogging member of either one of claims 68, 70, 72, 74, 78, 80, 82, 84, 86, and 88, wherein a drying step is inserted after completing the step for forming the basecoat layer.

90. A method for manufacturing antifogging member comprising: attaching a film described in claims 5, 17, 18, 19, 24, and 26, to the substrate.

91. A method for manufacturing antifogging member comprising: attaching the film described in claims 5, 17, 18, 19, 24, and 26, to the substrate via a binder.

92. A method for manufacturing antifogging member comprising a substrate, and a surface layer made of a photocatalyst and a hydrophilic material, while exposed surface being consisted only of the hydrophilic material,

which method comprising the steps of: applying a photocatalyst sol onto the surface of the substrate; firing the applied substrate; applying an amorphous material onto thus fired shape; then firing the shape again.

93. A method for manufacturing antifogging member comprising a substrate, and a surface layer made of a photocatalyst and a hydrophilic material, while exposed surface being consisted only of the hydrophilic material, which method comprising the steps of: applying a photocatalyst sol onto the surface of the substrate; applying an amorphous material onto the applied photocatalyst sol; then firing the applied substrate.

94. A method for manufacturing antifogging member comprising a substrate, and a surface layer made of a photocatalyst, a hydrophilic material, and an anti-bacterial metal, while exposed surface being consisted only of the hydrophilic material, which method comprising the steps of: applying a mixed solution of a photocatalyst sol and an anti-bacterial metal ion onto the surface of the substrate; firing the applied substrate; applying an amorphous material onto thus fired shape; then firing again the applied substrate.

95. A method for manufacturing antifogging member comprising a substrate, and a surface layer made of a photocatalyst, a hydrophilic material, and an anti-bacterial metal, while exposed surface being consisted only of the hydrophilic material, which method comprising the steps of:

applying a mixture of a photocatalyst sol and a solution containing an anti-bacterial metal ion onto the surface of the substrate; applying an amorphous material onto the applied mixed solution; then firing the applied substrate.

96. A method for manufacturing antifogging member comprising a substrate, and a surface layer made of a photocatalyst, a hydrophilic material, and an anti-bacterial metal, while exposed surface being consisted only of the hydrophilic material, which method comprising the steps of: applying a photocatalyst sol onto the surface of the substrate; firing the applied substrate; applying an amorphous material onto thus fired shape; firing the applied shape again; applying a solution containing an anti-bacterial metal ion onto thus re-fired shape; then irradiating light containing ultraviolet light to the shape.

97. A method for manufacturing antifogging member comprising a substrate, and a surface layer made of a photocatalyst, a hydrophilic material, and an anti-bacterial metal, while exposed surface being consisted only of the hydrophilic material, which method comprising the steps of: applying a photocatalyst sol onto the surface of the substrate; applying an amorphous material onto the photocatalyst sol layer; firing the applied substrate; applying a solution containing an anti-bacterial metal ion onto thus re-fired shape; then irradiating light containing ultraviolet light to the shape.

98. A method for manufacturing antifogging member

comprising a substrate, and a surface layer made of a photocatalyst, a hydrophilic material, and an anti-bacterial metal, while exposed surface being consisted only of the hydrophilic material, which method comprising the steps of: applying a photocatalyst sol onto the surface of the substrate; firing the applied substrate; applying an amorphous material onto thus fired shape; applying a solution containing an anti-bacterial metal ion onto the applied amorphous material; then firing the substrate again.

99. A method for manufacturing antifogging member comprising a substrate, and a surface layer made of a photocatalyst, a hydrophilic material, and an anti-bacterial metal, while exposed surface being consisted only of the hydrophilic material, which method comprising the steps of: applying a photocatalyst sol onto the surface of the substrate; applying an amorphous material onto the applied sol layer; applying a solution containing an anti-bacterial metallic ion onto the applied amorphous material; then firing the substrate.

100. A method for manufacturing antifogging member comprising a substrate, and a surface layer made of a photocatalyst, a hydrophilic material, and an anti-bacterial metal, while exposed surface being consisted only of the hydrophilic material, which method comprising the steps of: applying a photocatalyst sol onto the surface of the substrate; applying a solution containing an anti-bacterial metallic ion onto the applied photocatalyst sol layer; applying an amorphous material onto the applied anti-

bacterial metallic ion layer; then firing the substrate.

101. A method for manufacturing antifogging member comprising a substrate, and a surface layer made of a photocatalyst, a hydrophilic material, and an anti-bacterial metal, while exposed surface being consisted only of the hydrophilic material, which method comprising the steps of: applying a photocatalyst sol onto the surface of the substrate; firing the applied substrate; applying a solution containing an anti-bacterial metallic ion onto thus fired shape; applying an amorphous material onto the applied anti-bacterial metallic ion layer; then firing the substrate again.

102. A method for manufacturing antifogging member comprising a substrate, and a surface layer made of a photocatalyst, a hydrophilic material, and an anti-bacterial metal, while exposed surface being consisted only of the hydrophilic material, which method comprising the steps of: applying a photocatalyst sol onto the surface of the substrate; applying a solution containing an anti-bacterial metallic ion onto the applied photocatalyst sol layer; firing the applied substrate; applying an amorphous material onto thus fired shape; then firing the substrate again.

103. A method for preventing fogging of a member comprising: supplying dry air against the surface of the member having a hydrophilic exposed surface and having a means to sustain hydrophilicity.

104. A method for preventing fogging of a member comprising: irradiating ultraviolet light against the surface of the member having a hydrophilic exposed surface and having a means to sustain hydrophilicity.

[Detailed Description of the Invention]

[0001]

[Field of the Invention]

The present invention relates to a member provided by antifogging function and a method for manufacturing the member, which member is glass plates of automobiles, trains, airplanes, and the like, mirrors of bathrooms and lavatories, optical equipments, windowpanes of buildings, cathode ray tubes, and the like, and which member functions by letting light penetrate or reflect, (which member is hereinafter referred to simply as "translucent member"), and relates to an antifogging art for the translucent member.

[0002]

[Description of the Prior Art]

When glass plates of automobiles, trains, airplanes, and the like are fogged, safety driving thereof in rain is threatened.

If the mirrors in bathrooms, lavatories, and the like are not fogged, face washing is conveniently done. If the cathode ray tubes of TVs, personal computers, and the like are not fogged, our living style becomes more comfortable such that we can take a bath while watching TV.

[0003]

The mechanism of fogging on the surface of a member is the following. When water vapor molecules generated exceed

their saturation vapor pressure within an enclosed space, the water vapor molecules higher than the saturation vapor pressure are rejected from the vapor system. That is, the excess amount of water vapor molecules attach to solid materials in the enclosed space, to wall surface and floor surface, thus developing water droplets.

[0004]

To this point, the conventional antifogging art against these translucent members is to avoid the generation of saturation vapor pressure in the vicinity of the members.

In concrete terms, a transparent material layer which generates heat under application of electricity is formed on the surface of target member, thus increasing the surface temperature of the member. Alternatively, the surface of the target member is kept at or below the saturation pressure by charging dry air against the member surface.

[0005]

[Problems to be Solved by the Invention]

With the method to increase the surface temperature of the target member by forming a transparent material layer which generates heat by applying electricity onto the surface of the material, however, the desired surface temperature on the member surface cannot be sustained unless the electricity is applied continuously. The method is uneconomical one for antifogging art for a long period. Furthermore, the method is difficult to completely eliminate once occurred fog from the member surface.

The method to keep the surface of target member at or below the saturation vapor pressure by charging dry air against the surface of the member is also an uneconomical

method particularly in bathrooms because the method needs to continuously charge dry air. In addition, the method is also difficult to completely eliminate once occurred fog from the member surface.

The present invention was derived to cope with the situation, and an object of the present invention is to provide a translucent member that sustains antifogging effect for a long period.

[0006]

[Means to Solve the Problems]

To solve the above-described problems, the present invention provides an antifogging translucent member comprising a hydrophilic exposed surface and a means for sustaining the hydrophilic exposed surface.

[0007]

According to a preferred mode of the present invention, the antifogging member comprises a substrate, and a surface layer having a hydrophilic exposed surface having a means for sustaining the hydrophilic exposed surface.

[0008]

According to a preferred mode of the present invention, the means for sustaining the hydrophilic exposed surface is a photocatalyst.

[0009]

According to a preferred mode of the present invention, the size of particles and voids existing in the surface layer is 0.2 microns or less.

[0010]

According to a preferred mode of the present invention, a film made of a hydrophilic material contains a

the hydrophilicized photo-resistant resin is a resin having Si-O bond or Si-N bond in backbone thereof.

[0018]

According to a preferred mode of the present invention, the hydrophilicization is characterized by decomposition or oxidization of a portion of alkyl group or the like included in the resin comprising photo-resistant ingredient at least at the backbone thereof, which group reacts under irradiation of ultraviolet light.

[0019]

According to a preferred mode of the present invention, the surface layer contains an electron-acquiring metal.

[0020]

According to a preferred mode of the present invention, the surface layer contains an anti-bacterial metal.

[0021]

According to a preferred mode of the present invention, the surface layer contains silver.

[0022]

According to a preferred mode of the present invention, the film contains an electron-acquiring metal.

[0023]

According to a preferred mode of the present invention, the film contains an anti-bacterial metal.

[0024]

According to a preferred mode of the present invention, the film contains silver.

[0025]

According to a preferred mode of the present invention, the substrate is a glass or a mirror containing an

alkali-modified ingredient, and the intermediate layer is a layer to prevent diffusion of the alkali-modified ingredient.

[0026]

According to a preferred mode of the present invention, the layer to prevent diffusion of the alkali-modified ingredient is a high purity silica layer.

[0027]

According to a preferred mode of the present invention, the layer to prevent diffusion of the alkali-modified ingredient is a layer containing an electron-acquiring metal.

[0028]

According to a preferred mode of the present invention, the surface layer is made of a hydrophilicized photo-resistant resin and a photocatalyst, and the intermediate layer is a basecoat layer made of a resin.

[0029]

According to a preferred mode of the present invention, the film made of a hydrophilic material made of a hydrophilicized photo-resistant resin.

[0030]

According to a preferred mode of the present invention, a part of heat-generating means is added to the surface layer.

[0031]

According to a preferred mode of the present invention, a part of the heat-generating means is added to the film.

[0032]

According to a preferred mode of the present invention,

a part of the heat-generating means is a tin oxide transparent electrode to which a means for impressing voltage is connected.

[0033]

According to a preferred mode of the present invention, a translucent member comprises a plurality of translucent materials laminated to each other, wherein the surface layer forming the uppermost surface of the laminated materials has a hydrophilic exposed surface and a means for sustaining the hydrophilicity, and wherein a gap is formed between at least a pair of the laminated materials.

[0034]

According to a preferred mode of the present invention, a translucent member comprises a plurality of translucent materials laminated to each other, wherein the surface layer forming the uppermost surface of the laminated materials has a hydrophilic exposed surface, a means for sustaining the hydrophilicity, and a part of heat-generating means, and wherein a gap is formed between at least a pair of the laminated materials.

[0035]

According to a preferred mode of the present invention, a translucent member comprises a plurality of materials laminated to each other, wherein the surface layer forming the uppermost surface of the laminated materials has a hydrophilic exposed surface, means for sustaining the hydrophilicity, and a tin oxide translucent electrode, and wherein a gap is formed between at least a pair of the laminated materials, and wherein the electrode is connected with a means for impressing voltage thereto.

[0036]

According to a preferred mode of the present invention, a means for irradiating ultraviolet light is located at periphery of the translucent member.

[0037]

According to a preferred mode of the present invention, a rim section is located to enclose the means for irradiating ultraviolet light.

[0038]

According to a preferred mode of the present invention, the rim section is made by a reflection plate.

[0039]

According to a preferred mode of the present invention, a translucent member comprises a plurality of translucent materials laminated to each other, wherein the surface layer forming the uppermost surface of laminated materials has a hydrophilic exposed surface of the laminated materials and a means for sustaining the hydrophilicity, and wherein a means for irradiating ultraviolet light is located between at least a pair of the laminated materials.

[0040]

According to a preferred mode of the present invention, a means for irradiating ultraviolet light is located at rear face of the translucent member.

[0041]

According to a preferred mode of the present invention, the translucent member is a mirror.

[0042]

According to a preferred mode of the present invention, the translucent member is a mirror in bathroom or in

lavatory.

[0043]

The present invention provides a method for manufacturing antifogging translucent member comprising a hydrophilic film containing a photocatalyst, which method comprises the steps of: preparing a liquid by mixing a photocatalyst sol with a thermosetting resin having a photo-resistant ingredient in backbone thereof; heating to cure the liquid by pouring thereof into a mold; separating thus formed shape from the mold; then irradiating light containing ultraviolet light to the shape.

[0044]

The present invention provides a method for manufacturing antifogging translucent member comprising a hydrophilic film containing a photocatalyst and an anti-bacterial metal, which method comprises the steps of: mixing a photocatalyst sol with a solution containing an anti-bacterial metal ion; preparing a liquid by mixing the solution of photocatalyst sol with a thermosetting resin having a photo-resistant ingredient in backbone thereof; heating to cure the liquid by pouring thereof into a mold; separating thus formed shape from the mold; then irradiating light containing ultraviolet light to the shape.

[0045]

The present invention provides a method for manufacturing antifogging translucent member comprising a hydrophilic film containing a photocatalyst and an anti-bacterial metal, which method comprises the steps of: mixing a photocatalyst sol with a solution containing an anti-bacterial metal ion; irradiating light containing

ultraviolet light to the photocatalyst sol solution; preparing a liquid by mixing the solution of irradiated phoatocatalyst sol with a thermosetting resin having a photo-resistant ingredient in backbone thereof; heating to cure the liquid by pouring thereof into a mold; separating thus formed shape from the mold; then irradiating light containing ultraviolet light to the shape.

[0046]

The present invention provides a method for manufacturing antifogging translucent member comprising a hydrophilic film containing a photocatalyst and an anti-bacterial metal, which method comprises the steps of: preparing a liquid by mixing a photocatalyst sol with a thermosetting resin having a photo-resistant ingredient in backbone thereof; heating to cure the liquid by pouring thereof into a mold; separating thus formed shape from the mold; applying a solution containing an anti-bacterial metal ion onto the surface of the shape; then irradiating light containing ultraviolet light to the shape.

[0047]

The present invention provides a method for manufacturing antifogging translucent member comprising a hydrophilic film containing a photocatalyst, which method comprises the steps of: applying photocatalytic particles onto the surface of an injection molding die; conducting injection molding within the injection molding die using a compound of thermoplastic resin having a photo-resistant ingredient in backbone thereof; then irradiating light containing ultraviolet light to thus molded shape.

[0048]

The present invention provides a method for manufacturing antifogging translucent member comprising a hydrophilic film containing a photocatalyst, which method comprises the steps of: preparing mixed particles by fixing an anti-bacterial metal to photocatalytic particles; applying the mixed particles onto the surface of an injection molding die; conducting injection molding within the injection molding die using a compound of thermoplastic resin having a photo-resistant ingredient in backbone thereof; then irradiating light containing ultraviolet light to thus molded shape.

[0049]

The present invention provides a method for manufacturing antifogging translucent member comprising a glass substrate and a surface layer made of a hydrophilic photocatalyst, which method comprises the steps of: applying a precursor of photocatalyst onto the surface of the glass substrate; then firing the applied glass substrate.

[0050]

The present invention provides a method for manufacturing antifogging translucent member comprising a glass substrate containing an alkali metal or an alkali earth metal, and a surface layer made of a hydrophilic photocatalyst, which method comprises the steps of: forming a glass layer containing no alkali metal nor alkali earth metal onto a glass substrate containing an alkali metal or an alkali earth metal; applying a precursor of photocatalyst onto the surface of the glass substrate; then firing the applied glass substrate.

[0051]

The present invention provides a method for manufacturing antifogging translusent member comprising a mirror, and a surface layer made of a hydrophilic photocatalyst, which method comprises the steps of: applying a precursor of photocatalyst onto the surface of a glass before fabricating the mirror; firing the applied glass; then applying silver onto rear face of the glass using the silver mirror reaction.

[0052]

The present invention provides a method for manufacturing antifogging translucent member comprising a mirror, and a surface layer made of a hydrophilic photocatalyst, which method comprises the steps of: applying a precursor of photocatalyst onto the surface of a glass before fabricating the mirror; firing the applied glass; applying silver onto rear face of the glass using the silver mirror reaction; then protecting thus formed silver mirror section using a resin composition or the like.

[0053]

The present invention provides a method for manufacturing antifogging translucent member comprising a mirror, and a surface layer made of a hydrophilic photocatalyst, which method comprises the steps of: forming a glass layer containing no alkali metal nor alkali earth metal onto the surface of a glass before fabricating the mirror; applying a precursor of photocatalyst onto the surface of the glass layer; firing the applied glass; then applying silver onto rear face of the glass using the silver mirror reaction.

[0054]

The present invention provides a method for manufacturing antifogging translucent member comprising a mirror, and a surface layer made of a hydrophilic photocatalyst, which method comprises the steps of: forming a glass layer containing no alkali metal nor alkali earth metal onto a glass substrate before fabricating the mirror; applying a precursor of photocatalyst onto the surface of the glass layer; firing the applied glass; applying silver onto rear face of the glass using the silver mirror reaction; then protecting thus formed silver mirror section using a resin composition or the like.

[0055]

The present invention provides a method for manufacturing antifogging translucent member comprising a mirror, and a surface layer made of a hydrophilic photocatalyst, which method comprises the steps of: after fabricating the mirror, applying a precursor of photocatalyst onto the surface of the mirror; then firing the applied mirror.

[0056]

The present invention provides a method for manufacturing antifogging translucent member comprising a mirror, and a surface layer made of a hydrophilic photocatalyst, which method comprises the steps of: after fabricating the mirror, forming a glass layer containing no alkali metal nor alkali earth metal onto the surface of the mirror; applying a precursor of photocatalyst onto the glass layer; then firing the applied mirror.

[0057]

The present invention provides a method for manufacturing antifogging translucent member comprising a glass substrate, and surface layer made of a hydrophilic photocatalyst and an anti-bacterial metal, which method comprises the steps of: applying a precursor of photocatalyst onto the surface of the glass substrate; firing the applied glass substrate; applying a solution containing an anti-bacterial metal ion onto the surface of thus fired shape; then irradiating light including ultraviolet light to the shape.

[0058]

The present invention provides a method for manufacturing antifogging translucent member comprising a glass substrate, and a surface layer made of a hydrophilic photocatalyst and an anti-bacterial metal, which method comprises the steps of: forming a glass layer containing no alkali metal nor alkali earth metal onto the surface of the glass substrate; applying a precursor of photocatalyst onto the glass substrate, firing the applied glass layer; applying a solution containing an anti-bacterial metal ion onto the surface of the layer of applied precursor of photocatalyst; then irradiating light including ultraviolet light to thus fired shape.

[0059]

The present invention provides a method for manufacturing antifogging translucent member comprising a mirror, and a surface layer made of a hydrophilic photocatalyst and an anti-bacterial metal, which method comprises the steps of: applying a precursor of

photocatalyst onto the surface of a glass before fabricating the mirror; firing the applied glass; applying a solution containing an anti-bacterial metal ion onto the surface of the fired shape; irradiating light including ultraviolet light to the shape; then fixing silver onto rear face of the shape using the silver mirror reaction.

[0060]

The present invention provides a method for manufacturing antifogging translucent member comprising a mirror, and a surface layer made of a hydrophilic photocatalyst and an anti-bacterial metal, which method comprises the steps of: applying a precursor of photocatalyst onto the surface of a glass before fabricating the mirror; firing the applied glass; applying a solution containing an anti-bacterial metal ion onto the surface of thus fired shape; irradiating light including ultraviolet light to the shape; fixing silver onto rear face of the shape using the silver mirror reaction; then protecting thus formed silver mirror section with a resin composition or the like.

[0061]

The present invention provides a method for manufacturing antifogging translucent member comprising a mirror, and a surface layer made of a hydrophilic photocatalyst and an anti-bacterial metal, which method comprises the steps of: applying a precursor of photocatalyst onto the surface of a glass before fabricating the mirror; firing the applied glass; fixing silver onto rear face of thus fired shape using the silver mirror reaction; applying a solution containing an anti-bacterial

metal ion onto the surface of the shape; then irradiating light including ultraviolet light to the shape.

[0062]

The present invention provides a method for manufacturing antifogging translucent member comprising a mirror, and a surface layer made of a hydrophilic photocatalyst and an anti-bacterial metal, which method comprises the steps of: applying a precursor of photocatalyst onto the surface of a glass before fabricating the mirror; firing the applied glass; fixing silver onto rear face of thus fired shape using the silver mirror reaction; protecting thus formed silver mirror section with a resin composition or the like; applying a solution containing an anti-bacterial metal ion onto the surface of the shape; then irradiating light including ultraviolet light to the shape.

[0063]

The present invention provides a method for manufacturing antifogging translucent member comprising a mirror, and a surface layer made of a hydrophilic photocatalyst and an anti-bacterial metal, which method comprises the steps of: after fabricating the mirror, applying a precursor of photocatalyst onto the surface of the mirror; firing the applied mirror; applying a solution containing an anti-bacterial metal ion onto the surface of the fired mirror; then irradiating light including ultraviolet light to the mirror.

[0064]

The present invention provides a method for manufacturing antifogging translucent member comprising a

mirror, and a surface layer made of a hydrophilic photocatalyst and an anti-bacterial metal, which method comprises the steps of: forming a glass layer containing no alkali metal nor alkali earth metal onto the surface of a glass before fabricating the mirror; applying a precursor of photocatalyst onto the surface of the glass layer; firing the applied glass; applying a solution containing an anti-bacterial metal ion onto the surface of thus fired shape; irradiating light including ultraviolet light to the shape; then fixing silver onto rear face of the shape using the silver mirror reaction.

[0065]

The present invention provides a method for manufacturing antifogging translucent member comprising a mirror, and a surface layer made of a hydrophilic photocatalyst and an anti-bacterial metal, which method comprises the steps of: forming a glass layer containing no alkali metal nor alkali earth metal onto the surface of a glass before fabricating the mirror; applying a precursor of photocatalyst onto the surface of the glass layer; firing the applied glass; applying a solution containing an anti-bacterial metal ion onto the surface of thus fired shape; irradiating light containing ultraviolet light to the shape; fixing silver onto rear face of thus fired shape using the silver mirror reaction; then protecting thus formed silver mirror section using a resin composition and the like.

[0066]

The present invention provides a method for manufacturing antifogging translucent member comprising a

mirror, and a surface layer made of a hydrophilic photocatalyst and an anti-bacterial metal, which method comprises the steps of: forming a glass layer containing no alkali metal nor alkali earth metal onto the surface of a glass before fabricating the mirror; applying a precursor of photocatalyst onto the surface of the glass layer; firing the applied glass; fixing silver onto the rear face of thus fired shape using the silver mirror reaction; applying a solution containing an anti-bacterial metal ion onto the surface of the shape; then irradiating light including ultraviolet light to the shape.

[0067]

The present invention provides a method for manufacturing antifogging translucent member comprising a mirror, and a surface layer made of a hydrophilic photocatalyst and an anti-bacterial metal, which method comprises the steps of: forming a glass layer containing no alkali metal nor alkali earth metal onto the surface of a glass before fabricating the mirror; applying a precursor of photocatalyst onto the glass layer; firing the applied glass; fixing silver onto rear face of the glass using the silver mirror reaction; protecting thus formed silver mirror section by a resin composition or the like; applying a solution containing an anti-bacterial metal ion onto the protective resin layer; then irradiating light containing ultraviolet light against the applied glass.

[0068]

The present invention provides a method for manufacturing antifogging translucent member comprising a mirror, and a surface layer made of a hydrophilic

photocatalyst and an anti-bacterial metal, which method comprises the steps of: after fabricating the mirror, forming a glass layer containing no alkali metal nor alkali earth metal onto the surface of the mirror; applying a precursor of photocatalyst onto the surface of the glass layer; firing the applied glass; applying a solution containing an anti-bacterial metal ion onto the surface of thus fired shape; then irradiating light including ultraviolet light to the shape.

[0069]

According to a preferred mode of the present invention, the step for applying precursor of photocatalyst onto the surface of a substrate comprises the steps of: preparing an applying liquid by adding a diluent and a hydrolysis suppressor to alkoxide which is a precursor of photocatalyst; then applying the prepared liquid onto the surface of the glass substrate.

[0070]

According to a preferred mode of the present invention, the step for forming a glass layer containing no alkali metal nor alkali earth metal is a step for applying a precursor of silicon glass onto the surface of a glass substrate.

[0071]

According to a preferred mode of the present invention, the step for forming a glass layer containing no alkali metal nor alkali earth metal comprises the steps of: preparing an applying liquid by adding a diluent, water, and a hydrolysis suppressor to alkoxide which is a precursor of silicon glass; then applying thus prepared liquid onto the

surface of a glass substrate.

[0072]

According to a preferred mode of the present invention, the step for applying the applying liquid onto the surface of a substrate is conducted using dry air.

[0073]

The present invention provides a method for manufacturing antifogging translucent member comprising a substrate, and a surface layer consisting a hydrophilic photocatalyst and a hydrophilic material, which method comprises the steps of: preparing a liquid containing a photocatalyst sol and a photo-resistant thermosetting resin; applying thus prepared liquid onto the surface of the substrate; heating to cure the applied liquid; then irradiating light containing ultraviolet light to thus cured shape.

[0074]

The present invention provides a method for manufacturing antifogging translucent member comprising a substrate, and a surface layer consisting of a hydrophilic photocatalyst and a hydrophilic material, which method comprises the steps of: forming a basecoat layer onto the surface of the substrate; applying liquid containing a photocatalyst and a photo-resistant thermosetting resin onto the basecoat layer; heating to cure the applied liquid; then irradiating light containing ultraviolet light to thus cured shape.

[0075]

The present invention provides a method for manufacturing antifogging translucent member comprising a

substrate, and a surface layer consisting of a hydrophilic photocatalyst, a hydrophilic material, and an anti-bacterial metal, which method comprises the steps of; mixing a photocatalyst sol and a solution containing an anti-bacterial metal ion; preparing a liquid by adding a photo-resistant thermosetting resin to the solution; applying the liquid onto the basecoat layer; heating to cure the applied liquid; then irradiating light containing ultraviolet light to the cured shape.

[0076]

The present invention provides a method for manufacturing antifogging translucent member comprising a substrate, and a surface layer consisting of a hydrophilic photocatalyst, a hydrophilic material, and an anti-bacterial metal, which method comprises the steps of; forming a basecoat layer onto the surface of the substrate; mixing a photocatalyst sol and a solution containing an anti-bacterial metal ion; preparing a liquid by adding a photo-resistant thermosetting resin to the solution; applying the liquid onto the surface of the substrate; heating to cure the applied liquid; then irradiating light containing ultraviolet light to thus cured shape.

[0077]

The present invention provides a method for manufacturing antifogging translucent member comprising a substrate, and a surface layer consisting of a hydrophilic photocatalyst, a hydrophilic material, and an anti-bacterial metal, which method comprises the steps of: preparing a liquid containing a photocatalyst sol and a photo-resistant thermosetting resin; applying the liquid onto the surface of

the substrate; heating to cure the applied liquid; applying a solution containing an anti-bacterial metal ion onto thus cured shape; then irradiating light containing ultraviolet light to the shape.

[0078]

The present invention provides a method for manufacturing antifogging translucent member comprising a substrate, and a surface layer consisting of a hydrophilic photocatalyst and hydrophilic material, which method comprises the steps of: forming a basecoat layer onto the surface of the substrate; applying a liquid containing a photocatalyst sol and a photo-resistant thermosetting resin onto the surface of the basecoat layer; heating to cure the applied liquid; applying a solution containing an anti-bacterial metal ion onto thus cured shape; then irradiating light containing ultraviolet light to the shape.

[0079]

The present invention provides a method for manufacturing antifogging translucent member comprising a substrate, and a surface layer consisting of a hydrophilic photocatalyst and a hydrophilic material, which method comprises the steps of; after fabricating a mirror, applying a liquid containing a photocatalyst sol and a photo-resistant thermosetting resin onto the surface of the mirror; heating to cure the applied liquid; then irradiating light containing ultraviolet light to thus cured shape.

[0080]

The present invention provides a method for manufacturing antifogging translucent member comprising a substrate, and a surface layer consisting of a hydrophilic

photocatalyst and a hydrophilic material, which method comprises the steps of: after fabricating a mirror, forming a basecoat layer onto the surface of the mirror; applying a liquid containing a photocatalyst sol and a photo-resistant thermosetting resin onto the basecoat layer; heating to cure the applied liquid; then irradiating light containing ultraviolet light to thus cured shape.

[0081]

The present invention provides a method for manufacturing antifogging translucent member comprising a substrate, and a surface layer consisting of a hydrophilic photocatalyst and a hydrophilic material, which method comprising the steps of: applying a liquid containing a photocatalyst sol and a photo-resistant thermosetting resin onto the surface of a glass before fabricating a mirror, heating to cure the applied liquid; irradiating light containing ultraviolet light to thus cured shape; then fixing silver onto rear face of the shape using the silver mirror reaction.

[0082]

The present invention provides a method for manufacturing antifogging translucent member comprising a substrate, and a surface layer consisting of a hydrophilic photocatalyst and a hydrophilic material, which method comprises the steps of: forming a basecoat layer onto the surface of glass before fabricating a mirror; applying a liquid containing a photocatalyst sol and a photo-resistant thermosetting resin onto the basecoat layer; heating to cure the applied liquid; irradiating light containing ultraviolet light to thus cured shape; then fixing silver onto rear face

of the shape using the silver mirror reaction.

[0083]

The present invention provides a method for manufacturing antifogging translucent member comprising a substrate, and a surface layer consisting of a hydrophilic photocatalyst and a hydrophilic material, which method comprises the steps of: applying a liquid containing a photocatalyst sol and a photo-resistant thermosetting resin onto the surface of a glass before fabricating a mirror; heating to cure the applied liquid; fixing silver onto rear face of thus cured shape using the silver mirror reaction; then irradiating light containing ultraviolet light to the shape.

[0084]

The present invention provides a method for manufacturing antifogging translucent member comprising a substrate, and a surface layer consisting of a hydrophilic photocatalyst and a hydrophilic material, which method comprises the steps of: forming a basecoat layer onto the surface of a glass before fabricating a mirror; applying a liquid containing a photocatalyst sol and a photo-resistant thermosetting resin onto the basecoat layer; heating to cure the applied liquid; fixing silver onto rear face of thus cured shape using the silver mirror reaction; then irradiating light containing ultraviolet light to the shape.

[0085]

The present invention provides a method for manufacturing antifogging translucent member comprising a substrate, and a surface layer consisting of a hydrophilic photocatalyst, a hydrophilic material, and an anti-bacterial

metal, which method comprises the steps of: after fabricating a mirror, mixing a photocatalyst sol with a solution containing anti-bacterial metal ion; adding a photo-resistant thermosetting resin to the mixed solution; applying thus prepared solution onto the surface of the mirror; heating to cure the applied liquid; then irradiating light containing ultraviolet light to thus cured shape.
[0086]

The present invention provides a method for manufacturing antifogging translucent member comprising a substrate, and a surface layer consisting of a hydrophilic photocatalyst, a hydrophilic material, and an anti-bacterial metal, which method comprises the steps of: after fabricating a mirror, forming a basecoat layer on the surface of the mirror; mixing a photocatalyst sol with a solution containing anti-bacterial metal ion; adding a photo-resistant thermosetting resin to the mixed solution; applying thus prepared liquid onto the basecoat layer; heating to cure the applied liquid; then irradiating light containing ultraviolet light to thus cured shape.
[0087]

The present invention provides a method for manufacturing antifogging translucent member comprising a substrate, and a surface layer consisting of a hydrophilic photocatalyst, a hydrophilic material, and an anti-bacterial metal, which method comprises the steps of: after fabricating a mirror, applying a liquid containing a photocatalyst sol and a photo-resistant thermosetting resin onto the surface of the mirror; heating to cure the applied liquid; applying a solution containing an anti-bacterial

metal ion onto thus cured shape; then irradiating light containing ultraviolet light to the shape.

[0088]

The present invention provides a method for manufacturing antifogging translucent member comprising a substrate, and a surface layer consisting of a hydrophilic photocatalyst, a hydrophilic material, and an anti-bacterial metal, which method comprises the steps of: after fabricating a mirror, forming a basecoat layer on the mirror; applying a liquid containing a photocatalyst sol and a photo-resistant thermosetting resin onto the basecoat layer; heating to cure the applied liquid; applying a solution containing an anti-bacterial metal ion onto thus cured shape; then irradiating light containing ultraviolet light to the shape.

[0089]

The present invention provides a method for manufacturing antifogging translucent member comprising a substrate, and a surface layer consisting of a hydrophilic photocatalyst, a hydrophilic material, and an anti-bacterial metal, which method comprises the steps of: mixing a photocatalyst sol with a solution containing an anti-bacterial metal ion; adding a photo-resistant thermosetting resin to the mixture; applying thus prepared solution onto the surface of a glass before fabricating a mirror; heating to cure the applied solution; irradiating light containing ultraviolet light to the cured shape; then fixing silver onto rear face of the shape using the silver mirror reaction.

[0090]

The present invention provides a method for manufacturing antifogging translucent member comprising a substrate, and a surface layer consisting of a hydrophilic photocatalyst, a hydrophilic material, and an anti-bacterial metal, which method comprises the steps of: forming a basecoat layer on the surface of a glass before fabricating a mirror; mixing a photocatalyst sol with a solution containing an anti-bacterial metal ion; adding a photo-resistant thermosetting resin to the mixture; applying thus prepared solution onto the surface of the basecoat layer; heating to cure the applied solution; irradiating light containing ultraviolet light to thus cured shape; then fixing silver onto the rear face of the shape using the silver mirror reaction.

[0091]

The present invention provides a method for manufacturing antifogging translucent member comprising a substrate, and a surface layer consisting of a hydrophilic photocatalyst, a hydrophilic material, and an anti-bacterial metal, which method comprises the steps of: applying a liquid containing a photocatalyst sol and a photo-resistant thermosetting resin onto the surface of a glass before fabricating a mirror; heating to cure the applied liquid; applying a solution containing an anti-bacterial metal ion onto thus cured shape; irradiating light containing ultraviolet light to the shape; then fixing silver onto rear face of the shape using the silver mirror reaction.

[0092]

The present invention provides a method for

manufacturing antifogging translucent member comprising a substrate, and a surface layer consisting of a hydrophilic photocatalyst, a hydrophilic material, and an anti-bacterial metal, which method comprises the steps of; forming a basecoat layer onto the surface of a glass before fabricating a mirror; applying a liquid containing a photocatalyst sol and a photo-resistant thermosetting resin onto the basecoat layer; heating to cure the applied liquid; applying a solution containing an anti-bacterial metal ion onto thus cured shape; irradiating light containing ultraviolet light to the shape; then fixing silver onto rear face of the shape using the silver mirror reaction.

[0093]

The present invention provides a method for manufacturing antifogging translucent member comprising a substrate, and a surface layer consisting of a hydrophilic photocatalyst, a hydrophilic material, and an anti-bacterial metal, which method comprises the steps of: applying a liquid containing a photocatalyst sol and a photo-resistant thermosetting resin onto the surface of a glass before fabricating a mirror; heating to cure the applied liquid; fixing silver onto rear face of thus cured shape using the silver mirror reaction; applying a solution containing an anti-bacterial metal ion onto the surface of the shape; then irradiating light containing ultraviolet light to the shape.

[0094]

The present invention provides a method for manufacturing antifogging translucent member comprising a substrate, and a surface layer consisting of a hydrophilic

photocatalyst, a hydrophilic material, and an anti-bacterial metal, which method comprises the steps of: forming a basecoat layer onto the surface of a glass before fabricating a mirror; applying a liquid containing a photo-catalyst sol and a photo-resistant thermosetting resin onto the basecoat layer; heating to cure the applied liquid; fixing silver onto the rear face of thus cured shape using the silver mirror reaction; applying a solution containing an anti-bacterial metal ion onto the shape; then irradiating light containing ultraviolet light to the shape.

[0095]

According to a preferred mode of the present invention, a drying step is inserted after completing the step for forming the basecoat layer.

[0096]

According to a preferred mode of the present invention, an antifogging translucent film made of a hydrophilic material containing a photocatalyst is attached to the substrate.

[0097]

According to a preferred mode of the present invention, an antifogging translucent film made of a hydrophilic material containing a photocatalyst is attached to the substrate via a binder.

[0098]

The present invention provides a method for manufacturing antifogging translucent member comprising a substrate, and a surface layer made of a photocatalyst and a hydrophilic material, while exposed surface being consisted only of the hydrophilic material, which method comprises the

steps of: applying a photocatalyst sol onto the surface of the substrate; firing the applied substrate; applying an amorphous material onto thus fired shape; then firing the shape again.

[0099]

The present invention provides a method for manufacturing antifogging translucent member comprising a substrate, and a surface layer made of a photocatalyst and a hydrophilic material, while exposed surface being consisted only of the hydrophilic material, which method comprises the steps of: applying a photocatalyst sol onto the surface of the substrate; applying an amorphous material onto the applied photocatalyst sol; then firing the applied substrate.

[0100]

The present invention provides a method for manufacturing antifogging translucent member comprising a substrate, and a surface layer made of a photocatalyst, a hydrophilic material, and an anti-bacterial metal, while exposed surface being consisted only of the hydrophilic material, which method comprises the steps of: applying a mixed solution of a photocatalyst sol and an anti-bacterial metal ion onto the surface of the substrate; firing the applied substrate; applying an amorphous material onto thus fired shape; then firing again the applied substrate.

[0101]

The present invention provides a method for manufacturing antifogging translucent member comprising a substrate, and a surface layer made of a photocatalyst, a hydrophilic material, and an anti-bacterial metal, while

exposed surface being consisted only of the hydrophilic material, which method comprises the steps of: applying a mixture of a photocatalyst sol and a solution containing an anti-bacterial metal ion onto the surface of the substrate; applying an amorphous material onto the applied mixed solution; then firing the applied substrate.

[0102]

The present invention provides a method for manufacturing antifogging translucent member comprising a substrate, and a surface layer made of a photocatalyst, a hydrophilic material, and an anti-bacterial metal, while exposed surface being consisted only of the hydrophilic material, which method comprises the steps of; applying a photocatalyst sol onto the surface of the substrate; firing the applied substrate; applying an amorphous material onto thus fired shape; firing the applied shape again; applying a solution containing an anti-bacterial metal ion onto thus re-fired shape; then irradiating light containing ultraviolet light to the shape.

[0103]

The present invention provides a method for manufacturing antifogging translucent member comprising a substrate, and a surface layer made of a photocatalyst, a hydrophilic material, and an anti-bacterial metal, while exposed surface being consisted only of the hydrophilic material, which method comprises the steps of: applying a photocatalyst sol onto the surface of the substrate; applying an amorphous material onto the photocatalyst sol layer; firing the applied substrate; applying a solution containing an anti-bacterial metal ion onto thus re-fired

shape; then irradiating light containing ultraviolet light to the shape.

[0104]

The present invention provides a method for manufacturing antifogging translucent member comprising a substrate, and a surface layer made of a photocatalyst, a hydrophilic material, and an anti-bacterial metal, while exposed surface being consisted only of the hydrophilic material, which method comprises the steps of: applying a photocatalyst sol onto the surface of the substrate; firing the applied substrate; applying an amorphous material onto thus fired shape; applying a solution containing an anti-bacterial metal ion onto the applied amorphous material; then firing the substrate again.

[0105]

The present invention provides a method for manufacturing antifogging translucent member comprising a substrate, and a surface layer made of a photocatalyst, a hydrophilic material, and an anti-bacterial metal, while exposed surface being consisted only of the hydrophilic material, which method comprises the steps of: applying a photocatalyst sol onto the surface of the substrate; applying an amorphous material onto the applied sol layer; applying a solution containing an anti-bacterial metallic ion onto the applied amorphous material; then firing the substrate.

[0106]

The present invention provides a method for manufacturing antifogging translucent member comprising a substrate, and a surface layer made of a photocatalyst, a

hydrophilic material, and an anti-bacterial metal, while exposed surface being consisted only of the hydrophilic material, which method comprises the steps of: applying a photocatalyst sol onto the surface of the substrate; applying a solution containing an anti-bacterial metallic ion onto the applied photocatalyst sol layer; applying an amorphous material onto the applied anti-bacterial ion layer; then firing the substrate.

[0107]

The present invention provides a method for manufacturing antifogging translucent member comprising a substrate, and a surface layer made of a photocatalyst, a hydrophilic material, and an anti-bacterial metal, while exposed surface being consisted only of the hydrophilic material, which method comprises the steps of: applying a photocatalyst sol onto the surface of the substrate; firing the applied substrate; applying a solution containing an anti-bacterial metallic ion onto thus fired shape; applying an amorphous material onto the applied anti-bacterial metallic ion layer; then firing the substrate again.

[0108]

The present invention provides a method for manufacturing antifogging translucent member comprising a substrate, and a surface layer made a photocatalyst, a hydrophilic material, and an anti-bacterial metal, while exposed surface being consisted only of the hydrophilic material, which method comprises the steps of: applying a photocatalyst sol onto the surface of the substrate; applying solution containing an anti-bacterial metallic ion onto the applied photocatalyst sol layer; firing the applied

substrate; applying an amorphous material onto thus fired shape; then firing the substrate again.

[0109]

The present invention provides a method for preventing fogging of a translucent member, which method comprising: supplying dry air against the surface of the translucent member having a hydrophilic exposed surface and having a means to sustain hydrophilicity.

[0110]

The present invention provides a method for preventing fogging of a translucent member, which method comprising: irradiating ultraviolet light against the surface of the translucent member having a hydrophilic exposed surface and having a means to sustain hydrophilicity.

[0111]

[Constituent of the Invention]

Regarding the translucent member, the antifogging function is provided owing to the presence of a hydrophilic exposed surface and a means to sustain the hydrophilic exposed surface according to the mechanism described below.

Fogging on the surface of member appears when water vapor molecules having a vapor pressure above the saturation pressure are generated within an enclosed space, and when the supersaturated water vapor molecules are rejected from the enclosed space to condensate onto the wall surface and floor surface, thus growing to water droplets.

Appearance of the condensed waver vapor molecules differs with the size of droplets. When the wave length of light is expressed by ramda, the most significant fogging is observed when the droplet size is about half of ramade. The

reason is that the scattering efficiency of light becomes highest when the droplet size is about half of ramda.

[0112]

Accordingly, in the case of glass, for example, light passes through the glass with very little scattering if no droplet exists on the glass surface, so an observer inside of the enclosed space identifies that the glass is transparent. If, however, droplets appeared on the glass surface, and if the droplets grew to about half of ramda, light is scattered by the droplets, and the scattered light reaches the eyes of the observer, thus letting the observer identify fogging.

For the case of mirror, if there is no droplets on the mirror, the image reflected on the silver mirror section at rear face of the mirror reaches the eyes of the observer. If however, droplets appeared on the mirror, and if the droplets grew to a size of about half ramda, then the incident light and reflected light scatter owing to the droplets, thus generating contrast on the image, and fogging is observed.

[0113]

Therefore, no fogging appears when the surface of member is improved not to increase the droplet size to about half of ramda.

When the surface of the member is modified to hydrophilic, although water vapor molecules attach the surface of the material, the growing speed of the attached water vapor molecules is rapid, and they readily spread in film state so that no water droplet is formed and that no scattering of light appears, thus no fogging occurs.

To bring the surface of the member to hydrophilic, the member surface may be structured by a hydrophilic material. Typical hydrophilic materials include glass, polyamide, polyvinylidene fluoride.

[0114]

Glass shows a good hydrophilicity as-manufactured state showing about 5 to about 20 degrees of contact angle with water. When time elapsed, however, ingredients such as lower carboxylic acids or the like which contain both hydrophilic group and hydrophobic group gradually adsorb onto the glass surface, thus bringing the surface hydrophobic ("Glass Surface Design", Kindai Henshusha, Co., 1983). Accordingly, when water vapor molecules attach to the surface of material, they grow to water droplets. As a result, fogging likely occurs. In principle, polyamide and polyvinylidene fluoride induce similar phenomenon with the case of lower carboxylic acids to likely induce fogging.

Furthermore, polyamide and polyvinylidene fluoride have a disadvantage of soft and weak strength of film.

Conclusively, when the member surface is structured solely with a hydrophilic material, it is difficult to sustain antifogging performance for a long period.

[0115]

To this point, if a means to sustain the hydrophilic exposed surface is added, the above-described surface hydrophobic phenomenon does not appear. With the means, attached water vapor molecules on the material surface are effectively prevented from changing the property of member surface such as property to grow into water droplets, thus ensuring the prolonged antifogging performance.

[0116]

By adding a surface layer provided with a hydrophilic exposed surface and a means to sustain the hydrophilic exposed surface, antifogging function is favorably provided on the surface of various kinds of substrates.

[0117]

When the means for sustaining the hydrophilic exposed surface is a photocatalyst, only irradiation of sun light and lighting which contain ultraviolet light induces decomposition of the above-described ingredients so that the hydrophilicized surface is recovered. When the light including ultraviolet light is continuously irradiated, the hydrophilicized surface is sustained.

[0118]

If the size of particles and micropores in the surface layer is limited to 0.2 microns or less, no translucent performance is lost caused by scattering of light even when the thickness of the surface layer exceeds the wave length of visible light. Consequently, the hydrophobicizing is advantageously and effectively prevented by adding a large amount of the means to sustain the hydrophilic exposed surface.

[0119]

By adding a photocatalyst to the film made of a hydrophilic material, the hydrophilicity is sustained for a long period only by irradiating light to the film surface. In addition, by solely irradiating light to the surface, once-lost hydrophilicity on the surface is recovered. Accordingly, the film surface sustains antifogging performance for a long period.

[0120]

By forming a surface layer consisting only of a hydrophilic photocatalyst onto the substrate surface, the substrate surface sustains the hydrophilicity for a long period only by irradiating light to the surface thereof. In addition, by solely irradiating light to the surface, once-lost hydrophilicity on the surface is recovered. Accordingly, the substrate surface sustains antifogging performance for a long period.

[0121]

By forming a surface layer consisting of a hydrophilic photocatalyst and a hydrophilic material of non-photocatalyst onto the surface of substrate, the substrate surface sustains the hydrophilicity for a long period only by irradiating light to the surface thereof. In addition, by solely irradiating light to the surface, once-lost hydrophilicity on the surface is recovered. Accordingly, the substrate surface sustains antifogging performance for a long period.

[0122]

By forming a surface layer consisting of a hydrophilic photocatalyst and a hydrophilic material of non-photocatalyst onto the surface of substrate, and by forming the exposed surface by a hydrophilic material of non-photocatalyst, the substrate surface sustains the hydrophilicity for a long period only by irradiating light to the surface thereof. In addition, by solely irradiating light to the surface, once-lost hydrophilicity on the surface is recovered. Accordingly, the substrate surface sustains antifogging performance for a long period.

[0123]

By sandwiching an intermediate layer between the substrate and the surface layer, various kinds of functions are added to the intermediate layer. For example, when a transparent electrode is located in the intermediate layer and when the electrode is connected to the power source via leads, the antifogging function on the basis of heat-generating means is simultaneously functioned.

[0124]

For an antifogging translucent member comprising a substrate and a surface layer consisting of a hydrophilic photocatalyst and a hydrophilic material of non-photocatalyst, an antifogging translucent member comprising a film made of a hydrophilic material containing a photocatalyst, or an antifogging translucent member comprising a substrate and a surface layer consisting of a hydrophilic photocatalyst and a hydrophilic material of non-photocatalyst while exposed surface is made of a hydrophilic material of non-photocatalyst, if the hydrophilic material is preferably made of a hydrophilicized photo-resistant resin to allow manufacture the above-described antifogging translucent member only a simple process to mix the photocatalyst with the resin in a liquid followed by applying the mixture onto the substrate or to mold the mixture, then by treating at a low temperature ranging from ambient temperature to about 300℃ using a hydrophilicized photo-resistant resin as the hydrophilic material.

[0125]

For an antifogging translucent member comprising a

substrate and a surface layer consisting of a photocatalyst and surface layer consisting of a photocatalyst and hydrophilic material of non-photocatalyst, an antifogging translucent member comprising a film made of a hydrophilic material containing a photocatalyst, or an antifogging translucent member comprising a substrate and a surface layer consisting of a hydrophilic photocatalyst and a hydrophilic non-photocatalyst while exposed surface is made of a hydrophilic material of non-photocatalyst, the hydrophilic material is preferably made of an inorganic amorphous material to acquire a hard surface to sustain the antifogging performance for a long period and to recover the antifogging performance.

[0126]

By selecting a resin having Si-O bond or Si-N bond in the backbone of the hydrophilicized photo-resistant resin, the Si-O bond or S-N bond preferably has hydrophilicity, and the silicone resins and silazane resins such as siloxane resin, chlorosilane resin having these bonds in their backbone show highest photo-resistance among resins.

[0127]

When the hydrophilicization is carried out by irradiating ultraviolet light to a position of alkyl group, which reacts with ultraviolet light, contained in a resin structured by photo-resistant ingredient at least at the backbone thereof to decompose or oxidize, a hydrophilic surface having sufficient film strength is readily formed different from the case that direct addition of hydrophilic resin such as polyamide and polyvinylfluoride to the surface of the member.

[0128]

It is preferable to add an electron-acquiring metal to the surface layer because the additive significantly improves the deodorizing function based on the photocatalyst function is added to the above-described antifogging effect.

[0129]

It is preferable to add an anti-bacterial metal to the surface layer because a synergy effect of photocatlyst function and anti-bacterial metal to provide sufficient anti-bacterial force at the surface of member, adding to the above-described antifogging effect. It is also preferable to add the anti-bacterial metal because the anti-bacterial metal is gradually released into water, which provides water with anti-bacterial property under an environment that the member is used in bathroom, lavatory, toilet, kitchen, and the like.

[0130]

It is preferable to add silver to the surface layer because the above-described anti-bacterial property is functioned without degrading the sustaining performance of hydrophilicity and recovery function of photocatalyst.

[0131]

It is preferable to add an electron-acquiring metal to a film because the deodorizing function based on the photocatalytic function is significantly improved adding to the above-described antifogging effect.

[0132]

It is preferable to add an anti-bacterial metal to a film because the synergy effect of sufficient anti-bacterial force at the surface of member adding to the above-described

antifogging effect. Furthermore addition of anti-bacterial metal induces gradual release of the anti-bacterial metal into water, which provides water with anti-bacterial property under an environment that the member is used in bathroom, lavatory, toilet, kitchen, and the like.

[0133]

It is preferable to add silver to a film because the above-described anti-bacterial property is functioned without degrading the sustaining performance of hydrophilicity and recovery function of photocatalyst.

[0134]

When the substrate is glass or mirror containing alkali modified ingredients, and when the above-described intermediate layer is a layer to prevent diffusion of alkali modified ingredients, the diffusion of the alkali modified ingredients contained in the substrate to the surface is prevented during the production of member or during the use of the member, further the degradation of the activity of photocatalyst function caused by attaching alkali metal or alkali earth metal to the active centers of photocatalyst is prevented, thus ensuring to sustain the hydrophilicity and preventing the degradation of recovery function.

[0135]

At a low temperature level, alkali-modified ingredients have very small self-diffusion coefficient within a high purity silica layer. Accordingly, when the layer which prevents the diffusion of alkali-modified ingredients is formed by a high purity silica layer, the diffusion of alkali-modified ingredients in the substrate to the surface during the manufacture of member or during the use of the

member is effectively prevented, further the degradation of the activity of photocatalyst function caused by attaching alkali metal or alkali earth metal to the active centers of photocatalyst is prevented, thus ensuring to sustain the hydrophilicity and preventing the degradation of recovery function.

[0136]

When the layer preventing the diffusion of alkali-modified ingredients is formed by a layer containing an electron-acquiring metal, the diffusion of alkali-modified ingredients in the substrate to the surface during the manufacture of member or during the use of the member is effectively prevented, further the degradation of the activity of photocatalyst function caused by attaching alkali metal or alkali earth metal to the active centers of photocatalyst is prevented, thus ensuring to sustain the hydrophilicity and preventing the degradation of recovery function and to improving the deodorizing function based on the photocatalyst.

[0137]

When the surface layer is structured with a hydrophilicized photo-resistant resin and a photocatalyst, and when the intermediate layer is formed by a basecoat layer of resin, the following-described five advantages appear.

First, the substrate and the surface layer are more firmly bonded together than ever, thus anti-separation performance is improved. This is because a film consisting solely of resin gives higher film strength and higher adhesiveness than a film made of a mixture of resin and

photocatalyst.

[0138]

Second, the improved anti-separation performance of the film increases the percentage of photocatalyst in the surface layer for the same film strength, so the effect to sustain the hydrophilicity is further improved.

[0139]

Third, by keeping the effect of photocatalyst to sustain the hydrophilicity to a constant level, the surface layer become thinner because the photocatalyst is able to concentrate into the surface layer.

[0140]

Fourth, the resin in the surface layer is necessary to have a structure that the backbone of polymer has photoresistance and is a resin to be hydrophilicized, (or a resin having backbone of Si-O bond, Si-N bond, and the like). That type of resin is, however, arbitrarily selected if only it has transmissivity.

Consequently, if the basecoat layer is fabricated by more inexpensive resin, the production cost becomes less.

If the difference of thermal expansion coefficient is significant between the substrate and the surface layer, possibility of crack generation during heat treatment is avoided when the applied resin to form the basecoat layer is the one having elasticity or the one having moderate thermal expansion coefficient.

[0141]

Fifth, a substrate having significant surface irregularity is smoothened its surface by applying the basecoat layer, which induces the following-described

effect.

That is, the uppermost surface layer is readily formed in smooth surface. If the uppermost surface layer is smooth, then light is efficiently irradiated against the photocatalyst, and the effect to sustain the hydrophilicity is more effectively performed. Furthermore, photocatalyst is distributed nearly uniformly over the whole film, thus the effect to sustain the hydrophilicity appears over the whole substrate area to uniformly function.

[0142]

When a part of the heat-generation means is added to the surface layer, the temperature rise in the member prohibits the deposition of water vapor molecules onto the surface, thus further improving the antifogging effect.

[0143]

When a part of the heat-generation means is added to a film, the temperature rise in the member prohibits the deposition of water vapor molecules onto the surface, thus further improving the antifogging effect.

[0144]

When a part of the heat-generation means described above is a transparent tin oxide electrode, and when a means to impress voltage to the electrode is connected to the heat-generation means, the means is relatively easily integrated to the member. Since tin oxide is a hydrophilic material, it is possible to apply tin oxide onto the surface layer.

[0145]

When the translucent member is fabricated by laminating plurality of translucent materials and when the surface

layer of the translucent material which forms the uppermost layer of the translucent member has a hydrophilic exposed surface and a means to sustain the hydrophilicity, also has a gap between at least a pair of translucent materials, a heat-holding effect is generated by entering air into the gap adding to the effect of antifogging induced by the hydrophilic exposed surface and the means to sustain the hydrophilicity. As a result, even when the peripheral air is suddenly cooled, supersaturation of water vapor molecules is hard to appear on the surface of the member, thus further improving the antifogging effect.

[0146]

When the translucent member is fabricated by laminating plurality of translucent materials and when the surface layer of the translucent material which forms the uppermost layer of the translucent member has a hydrophilic exposed surface, a means to sustain the hydrophilicity, and a part of a means to generate heat, also has a gap between at least a pair of translucent materials, temperature rise of the member prevents the deposition of water vapor molecules. In addition, air enters the gap induces the heat holding effect to sustain the elevated temperature state of the member. As a result, the antifogging effect is further improved.

[0147]

A preferable mode is a translucent member fabricated by laminating plurality of translucent materials. The surface layer of the translucent material which forms the uppermost surface has a hydrophilic exposed surface, a means to sustain the hydrophilicity, and a transparent tin oxide electrode. Also the surface layer has a gap between at

least a pair of translucent materials, and has a connected means to impress voltage to the above-described electrode. The configuration allows to relatively easily integrate the electrode into the translucent member. Since tin oxide is a hydrophilic material, it can be applied onto the surface layer.

[0148]

When a means to irradiate ultraviolet light is added to the periphery of translucent material, the light source is positioned nearer than the case of room lighting and solar rays. Accordingly, more intense ultraviolet light is irradiated to the surface of the member. As a result, maintaining hydrophilicity and recovery effect is realized in shorter period.

[0149]

It is preferable that a rim section is provided to enclose the means to irradiate ultraviolet light, for instance the case of mirror, because light does not directly irradiate to operator's eyes even when the member is used under a condition of light source in ON mode.

If the above-described rim section is formed by a reflection plate, the illuminance of ultraviolet light irradiated to the translucent member is increased, so maintaining hydrophilicity and recovery effect is realized in a short period.

[0150]

When the translucent member is fabricated by laminating plurality of translucent materials and when the surface layer of the translucent material which forms the uppermost layer of the translucent member has a hydrophilic exposed

surface, a means to sustain the hydrophilicity, and a means to irradiate ultraviolet light between at least a pair of translucent materials, it becomes possible to maintain the hydrophilicity and improve the recovery effect owing to the improved illuminance of the ultraviolet light, and to further improve the antifogging effect by the heat holding effect induced by entering air to gap, thus suppressing supersaturation of water vapor molecules on the member surface.

[0151]

When a means to irradiate ultraviolet light to a rear surface of the translucent member, the light source is positioned nearer than the case of room lighting and solar rays. Accordingly, more intense ultraviolet light is irradiated to the surface of the member. As a result, maintaining hydrophilicity and recovery effect is realized in shorter period.

If the means to irradiate ultraviolet light is a flat light source, a means to irradiate ultraviolet light is readily prepared only by fixing the flat light source to the rear surface through adhering or baking, or the like.

[0152]

When the translucent member is a mirror, existed problem of fogging and inconvenience, particularly at lavatory and bathroom, are solved.

[0153]

In a method for manufacturing antifogging translucent member comprising a hydrophilic film containing a photocatalyst, the hydrophilic film having relatively high hardness is easily formed by the steps of: preparing a

liquid by mixing a photocatalyst sol with a thermosetting resin having a photo-resistant ingredient in backbone thereof; heating to cure the liquid by pouring thereof into a mold; separating thus formed shape from the mold; then irradiating light containing ultraviolet light to the shape. Irradiation of light containing ultraviolet light at the final step makes the hydrophobic section such as alkyl in the thermosetting resin having photo-resistant ingredients exposed to the surface of member in the backbone thereof decomposed and oxidized, thus hydrophilicized, while the photo-resistant ingredients structuring the backbone of the resin are not changed.

[0154]

In a method for manufacturing antifogging translucent member comprising a hydrophilic film containing a photocatalyst and an anti-bacterial metal, the hydrophilic film having relatively high hardness is easily formed by the stops of: mixing a photocatalyst sol with a solution containing an anti-bacterial metal ion; preparing a liquid by mixing the solution of photocatalyst sol with a thermosetting resin having a photo-resistant ingredient in backbone thereof; heating to cure the liquid by pouring thereof into a mold; separating thus formed shape from the mold; then irradiating light containing ultraviolet light to the shape. Irradiation of light containing ultraviolet light at the final step makes the hydrophobic section such as alkyl in the thermosetting resin having photo-resistant ingredients exposed to the surface of member in the backbone thereof decomposed and oxidized, thus hydrophilicized, while the photo-resistant ingredients structuring the backbone of

the resin are not changed.

[0155]

In a method for manufacturing antifogging translucent member comprising a hydrophilic film containing a photocatalyst and an anti-bacterial metal, the hydrophilic film having relatively high hardness is easily formed by the steps of: mixing a photocatalyst sol with a solution containing an anti-bacterial metal ion; irradiating light containing ultraviolet light to the photocatalyst sol solution; preparing a liquid by mixing the solution of irradiated photocatalyst sol with a thermosetting resin having a photo-resistant ingredient in backbone thereof; heating to cure the liquid by pouring thereof into a mold; separating thus formed shape from the mold; then irradiating light containing ultraviolet light to the shape. Irradiation of light containing ultraviolet light at the final step makes the hydrophobic section such as alkyl in the thermosetting resin having photo-resistant ingredients exposed to the surface of member in the backbone thereof decomposed and oxidized, thus hydrophilicized, while the photo-resistant ingredients structuring the backbone of the resin are not changed.

[0156]

In a method for manufacturing antifogging translucent member comprising a hydrophilic film containing a photocatalyst and an anti-bacterial metal, the hydrophilic film having relatively high hardness is easily formed by the steps of: preparing a liquid by mixing a photocatalyst sol with a thermosetting resin having a photo-resistant ingredient in backbone thereof; heating to cure the liquid

by pouring thereof into a mold; separating thus formed shape from the mold; applying a solution containing an anti-bacterial metal ion onto the surface of the shape; then irradiating light containing ultraviolet light to the shape. Irradiation of light containing ultraviolet light at the final step makes the hydrophobic section such as alkyl in the thermosetting resin having photo-resistant ingredients exposed to the surface of member in the backbone thereof decomposed and oxidized, thus hydrophilicized, while the photo-resistant ingredients structuring the backbone of the resin are not changed.

[0157]

In a method for manufacturing antifogging translucent member comprising a hydrophilic film containing a photocatalyst, the hydrophilic film having relatively high hardness is easily formed by the steps of: applying photocatalytic particles onto the surface of an injection molding die; conducting injection molding within the injection molding die using a compound of thermoplastic resin having a photo-resistant ingredient in backbone thereof; then irradiating light containing ultraviolet light to thus molded shape. Irradiation of light containing ultraviolet light at the final step makes the hydrophobic section such as alkyl in the thermosetting resin having photo-resistant ingredients exposed to the surface of member in the backbone thereof decomposed and oxidized, thus hydrophilicized, while the photo-resistant ingredients structuring the backbone of the resin are not changed.

[0158]

In a method for manufacturing antifogging translucent

member comprising a hydrophilic film containing a photocatalyst, the hydrophilic film having relatively high hardness is easily formed by the steps of: preparing mixed particles by fixing an anti-bacterial metal to photocatalytic particles; applying the mixed particles onto the surface of an injection molding die; conducting injection molding within the injection molding die using a compound of thermoplastic resin having a photo-resistant ingredient in backbone thereof; then irradiating light containing ultraviolet light to thus molded shape. Irradiation of light containing ultraviolet light at the final step makes the hydrophobic section such as alkyl in the thermosetting resin having photo-resistant ingredients exposed to the surface of member in the backbone thereof decomposed and oxidized, thus hydrophilicized, while the photo-resistant ingredients structuring the backbone of the resin are not changed.

[0159]

In a method for manufacturing antifogging translucent member comprising a glass substrate and a surface layer made of a hydrophilic photocatalyst formed on the substrate, the glass having high surface hardness and being able to maintain and recover the hydrophilicity for a long period is easily obtained by the steps of: applying a precursor of photocatalyst onto the surface of the glass substrate; then firing the applied glass substrate.

[0160]

In a method for manufacturing antifogging translucent member comprising a glass substrate containing alkali metal or alkali earth metal, and a surface layer made of a

hydrophilic photocatalyst formed thereon, the glass having high surface hardness and being able to maintain and recover the hydrophilicity for a long period is easily obtained even for a glass containing alkali metal or alkali earth metal by the steps of: forming a glass layer containing no alkali metal nor alkali earth metal onto a glass substrate containing an alkali metal or an alkali earth metal; applying a precursor of photocatalyst onto the surface of the glass substrate; then firing the applied glass substrate.

[0161]

In a method for manufacturing antifogging translucent member comprising a mirror and a surface layer made of a hydrophilic photocatalyst formed thereon, the mirror having high surface hardness and being able to maintain and recover the hydrophilicity for a long period is easily obtained by the steps of: applying a precursor of photocatalyst onto the surface of a glass before fabricating the mirror; firing the applied glass; then applying silver onto rear face of the glass using the silver mirror reaction.

[0162]

In a method for manufacturing antifogging translucent member comprising a mirror and a surface layer made of a hydrophilic photocatalyst formed thereon, the mirror having high surface hardness and being able to maintain and recover the hydrophilicity for a long period is easily obtained independent of the heat resistance of silver mirror protective material such as resin composition by the steps of: applying a precursor of photocatalyst onto the surface of a glass before fabricating the mirror; firing the applied

glass; applying silver onto rear face of the glass using the silver mirror reaction; then protecting thus formed silver mirror section using a resin composition or the like.

[0163]

In a method for manufacturing antifogging translucent member comprising a mirror and a surface layer made of a hydrophilic photocatalyst formed thereon, the mirror having high surface hardness and being able to maintain and recover the hydrophilicity for a long period is easily obtained, even if the glass for manufacturing the mirror contains alkali metal and alkali earth metal, by the steps of: forming a glass layer containing no alkali metal nor alkali earth metal onto the surface of a glass before fabricating the mirror; applying a precursor of photocatalyst onto the surface of the glass layer; firing the applied glass; then applying silver onto rear face of the glass using the silver mirror reaction.

[0164]

In a method for manufacturing antifogging translucent member comprising a mirror and a surface layer made of a hydrophilic photocatalyst formed thereon, the mirror having high surface hardness and being able to maintain and recover the hydrophilicity for a long period is easily obtained, independent of the heat resistance of the silver mirror section protective material such as resin composition and even if the glass for manufacturing the mirror contains alkali metal and alkali earth metal, by the steps of: forming a glass layer containing no alkali metal nor alkali earth metal onto a glass substrate before fabricating the mirror; applying a precursor of photocatalyst onto the

surface of the glass layer; firing the applied glass; applying silver onto rear face of the glass using the silver mirror reaction; then protecting thus formed silver mirror section using a resin composition or the like.

[0165]

In a method for manufacturing antifogging translucent member comprising a mirror and a surface layer made of a hydrophilic photocatalyst formed thereon, the mirror having high surface hardness and being able to maintain and recover the hydrophilicity for a long period is easily obtained, if only the heat resistance of mirror-structuring materials such as silver mirror protective material such as resin composition is in an approximate range of from 400℃ to 500℃, by the steps of: after fabricating the mirror, applying a precursor of photocatalyst onto the surface of the mirror; then firing the applied mirror.

[0166]

In a method for manufacturing antifogging translucent member comprising a mirror and a surface layer made of a hydrophilic photocatalyst formed thereon, the mirror having high surface hardness and being able to maintain and recover the hydrophilicity for a long period is easily obtained even if the glass for manufacturing the mirror contains alkali metal and alkali earth metal, if only the heat resistance of mirror-structuring materials such as silver mirror protective material such as resin composition is in an approximate range of from 400℃ to 500℃, by the steps of: after fabricating the mirror, forming a glass layer containing no alkali metal nor alkali earth metal onto the surface of the mirror; applying a precursor of photocatalyst

onto the glass layer; then firing the applied mirror.

[0167]

In a method for manufacturing antifogging translucent member comprising a glass substrate, and surface layer made of a hydrophilic photocatalyst and an anti-bacterial metal formed thereon, the glass having high surface hardness, being able to maintain and recover the hydrophilicity for a long period, and having anti-bacterial property is easily obtained by the steps of: applying a precursor of photocatalyst onto the surface of the glass substrate; firing the applied glass substrate; applying a solution containing an anti-bacterial metal ion onto the surface of thus fired shape; then irradiating light including ultraviolet light to the shape.

[0168]

In a method for manufacturing antifogging translucent member comprising a glass substrate, and a surface layer made of a hydrophilic photocatalyst and an anti-bacterial metal formed thereon, the glass having high surface hardness, being able to maintain and recover the hydrophilicity for a long period, and having anti-bacterial property is easily obtained, even if the glass for manufacturing the mirror contains alkali metal and alkali earth metal, by the steps of: forming a glass layer containing no alkali metal nor alkali earth metal onto the surface of the glass substrate; applying a precursor of photocatalyst onto the glass substrate; firing the applied glass layer; applying a solution containing an anti-bacterial metal ion onto the surface of the layer of applied precursor of photocatalyst; then irradiating light including

ultraviolet light to thus fired shape.

[0169]

In a method for manufacturing antifogging translucent member comprising a mirror, and a surface layer made of a hydrophilic photocatalyst and an anti-bacterial metal, the mirror having high surface strength, being able to maintain and recover the hydrophilicity for a long period, and having anti-bacterial property is easily obtained by the steps of: applying a precursor of photocatalyst onto the surface of a glass before fabricating the mirror; firing the applied glass; applying a solution containing an anti-bacterial metal ion onto the surface of the fired shape; irradiating light including ultraviolet light to the shape; then fixing silver onto rear face of the shape using the silver mirror reaction.

[0170]

In a method for manufacturing antifogging translucent member comprising a mirror, and a surface layer made of a hydrophilic photocatalyst and an anti-bacterial metal, the mirror having high surface strength, being able to maintain and recover the hydrophilicity for a long period, and having anti-bacterial property is easily obtained independent of the heat resistance of silver mirror section protective material such as resin composition by the steps of: applying a precursor of photocatalyst onto the surface of a glass before fabricating the mirror; firing the applied glass; applying a solution containing an anti-bacterial metal ion onto the surface of thus fired shape; irradiating light including ultraviolet light to the shape; fixing silver onto rear face of the shape using the silver mirror reaction;

then protecting thus formed silver mirror section with a resin composition or the like.

[0171]

In a method for manufacturing antifogging translucent member comprising a mirror, and a surface layer made of a hydrophilic photocatalyst and an anti-bacterial metal, the mirror having high surface strength and being able to maintain and recover the hydrophilicity for a long period is easily obtained by the steps of: applying a precursor of photocatalyst onto the surface of a glass before fabricating the mirror; firing the applied glass; fixing silver onto rear face of thus fired shape using the silver mirror reaction; applying a solution containing an anti-bacterial metal ion onto the surface of the shape; then irradiating light including ultraviolet light to the shape.

[0172]

In a method for manufacturing antifogging translucent member comprising a mirror, and surface layer made of a hydrophilic photocatalyst and an anti-bacterial metal, the mirror having high surface strength, being able to maintain and recover the hydrophilicity for a long period, and having anti-bacterial property is easily obtained independent of the heat resistance of silver mirror section protective material such as resin composition by the steps of: applying a precursor of photocatalyst onto surface of a glass before fabricating the mirror; firing the applied glass; fixing silver onto rear face of thus fired shape using the silver mirror reaction; protecting thus formed silver mirror section with a resin composition or the like; applying a solution containing an anti-bacterial metal ion onto the

surface of the shape; then irradiating light including ultraviolet light to the shape.

[0173]

In a method for manufacturing antifogging translucent member comprising a mirror, and a surface layer made of a hydrophilic photocatalyst and an anti-bacterial metal, the mirror having high surface strength, being able to maintain and recover the hydrophilicity for a long period, and having anti-bacterial property is easily obtained, if only the heat resistance of mirror-structuring materials such as silver mirror protective material such as resin composition is in an approximate range of from 400℃ to 500℃, by the steps of: after fabricating the mirror, applying a precursor of photocatalyst onto the surface of the mirror; firing the applied mirror; applying a solution containing an anti-bacterial metal ion onto the surface of the fired mirror; then irradiating light including ultraviolet light to the mirror.

[0174]

In a method for manufacturing antifogging translucent member comprising a mirror, and a surface layer made of a hydrophilic photocatalyst and an anti-bacterial metal, the mirror having high surface strength, being able to maintain and recover the hydrophilicity for a long period, and having anti-bacterial property is easily obtained, if the glass for manufacturing the mirror contains alkali metal and alkali earth metal, by the steps of; forming a glass layer containing no alkali metal nor alkali earth metal onto the surface of a glass before fabricating the mirror; applying a precursor of photocatalyst onto the surface of the glass

layer; firing the applied glass; applying a solution containing an anti-bacterial metal ion onto the surface of thus fired shape; irradiating light including ultraviolet light to the shape; then fixing silver onto rear face of the shape using the silver mirror reaction.

[0175]

In a method for manufacturing antifogging translucent member comprising a mirror, and a surface layer made of a hydrophilic photocatalyst and an anti-bacterial metal, the mirror having high surface strength, being able to maintain and recover the hydrophilicity for a long period, and having anti-bacterial property is easily obtained independent of the heat resistance of silver mirror section protective material such as resin composition, even if the glass for manufacturing the mirror contains alkali metal and alkali earth metal, by the steps of: forming a glass layer containing no alkali metal nor alkali earth metal onto the surface of a glass before fabricating the mirror, applying a precursor of photocatalyst onto the surface of the glass layer; firing the applied glass; applying a solution containing an anti-bacterial metal ion onto the surface of thus fired shape; irradiating light including ultraviolet light to the shape; fixing silver onto rear face of the shape using the silver mirror reaction; then protecting thus formed silver mirror section using a resin composition or the like.

[0176]

In a method for manufacturing antifogging translucent member comprising a mirror, and a surface layer made of a hydrophilic photocatalyst and an anti-bacterial metal, the

mirror having high surface strength, being able to maintain and recover the hydrophilicity for a long period, and having anti-bacterial property is easily obtained, even if the glass for manufacturing the mirror contains alkali metal and alkali earth metal, by the steps of: forming a glass layer containing no alkali metal nor alkali earth metal onto the surface of a glass before fabricating the mirror; applying a precursor of photocatalyst onto the surface of the glass layer; firing the applied glass; fixing silver onto rear face of thus fired shape using the silver mirror reaction; applying a solution containing an anti-bacterial metal ion onto the surface of the shape; then irradiating light including ultraviolet light to the shape.

[0177]

In a method for manufacturing antifogging translucent member comprising a mirror, and a surface layer made of a hydrophilic photocatalyst and an anti-bacterial metal, the mirror having high surface strength, being able to maintain and recover the hydrophilicity for a long period, and having anti-bacterial property is easily obtained independent of the heat resistance of silver mirror section protective material such as resin composition, even if the glass for manufacturing the mirror contains alkali metal and alkali earth metal, by the steps of: forming a glass layer containing no alkali metal nor alkali earth metal onto the surface of a glass before fabricating the mirror; applying a precursor of photocatalyst onto the surface of the glass layer; firing the applied glass; fixing silver onto the rear face of thus fired shape using the silver mirror reaction; protecting thus formed silver mirror section using a resin

composition or the like; applying a solution containing an anti-bacterial metal ion onto the surface of the shape; then irradiating light including ultraviolet light to the shape.

[0178]

In a method for manufacturing antifogging translucent member comprising a mirror, and a surface layer made of a hydrophilic photocatalyst and an anti-bacterial metal, the mirror having high surface strength, being able to maintain and recover the hydrophilicity for a long period, and having anti-bacterial property is easily obtained independent of the heat resistance of silver mirror section protective material such as resin composition, even if the glass for manufacturing the mirror contains alkali metal and alkali earth metal, by the steps of: after fabricating the mirror, forming a glass layer containing no alkali metal nor alkali earth metal onto the surface of the mirror; applying a precursor of photocatalyst onto the surface of the glass layer; firing the applied glass; applying a solution containing an anti-bacterial metal ion onto the surface of thus fired shape; then irradiating light including ultraviolet light to the shape.

[0179]

When the steps of applying the precursor of photocatalyst to the surface of the substrate are in a sequent order of preparing an applying liquid by adding a diluent and a hydrolysis suppressor to alkoxide which is a precursor of photocatalyst, then applying the prepared liquid onto the surface of the glass substrate, the alkoxide which is a precursor of the photocatalyst applied to the substrate is hydrolyzed by moisture in atmospheric air to

yield an oxide hydrate, further dehydrated and condensed during the period of heating in the firing step, thus yielding amorphous oxide, followed by precipitating fine crystals of photocatalyst. Therefore, a surface layer having dense structure and superior photocatalytic activity is formed at a low temperature level around 400℃.

[0180]

When the step to form a glass containing no alkali metal and alkali earth metal is a step to apply a precursor of silicon glass to the surface of glass substrate, an intermediate layer of high purity silica containing no alkali earth metal is easily formed.

[0181]

A preferred mode of the step to apply the above-described precursor of silicon glass to the surface of glass substrate comprises the steps of: preparing an applying liquid by adding a diluent, water, and a hydrolysis suppressor to alkoxide which is a precursor of silicon glass; then applying thus prepared liquid onto the surface of a glass substrate.

[0182]

It is preferable to use dry air in the step for applying a coating liquid to the surface of substrate because the crack generation is prevented even when a precursor of photocatalyst such as titanium alkoxide which is likely hydrolyzed is used.

[0183]

In a method for manufacturing antifogging translucent member comprising a substrate, and a surface layer made of a hydrophilic photocatalyst and a hydrophilic material, the

member having relatively high surface strength, and being able to maintain and recover the hydrophilicity for a long period is easily obtained by the steps of: preparing a liquid containing a photocatalyst sol and a photo-resistant thermosetting resin; applying thus prepared liquid onto the surface of the substrate; heating to cure the applied liquid; then irradiating light containing ultraviolet light to thus cured shape. Irradiation of light containing ultraviolet light at the final step makes the hydrophobic section such as alkyl in the thermosetting resin having photo-resistant ingredients exposed to the surface of member in the backbone thereof decomposed and oxidized, thus hydrophilicized, while the photo-resistant ingredients structuring the backbone of the resin are not changed.

[0184]

In a method for manufacturing antifogging translucent member comprising a substrate, and a surface layer made of a hydrophilic photocatalyst and a hydrophilic material, the member having smooth surface layer, relatively high surface strength, and being able to maintain and recover the hydrophilicity for a long period is easily obtained, even when the surface of substrate is irregular, by the steps of: forming a basecoat layer onto the surface of the substrate; applying a liquid containing a photocatalyst and a photo-resistant thermosetting resin onto the basecoat layer; heating to cure the applied liquid; then irradiating light containing ultraviolet light to thus cured shape.

[0185]

In a method for manufacturing antifogging translucent member comprising a substrate, and surface layer made of a

hydrophilic photocatalyst, a hydrophilic material, and an anti-bacterial metal, the member having relatively high surface strength, and being able to maintain and recover the hydrophilicity for a long period is easily obtained by the steps of: mixing a photocatalyst sol and a solution containing an anti-bacterial metal ion; preparing a liquid by adding a photo-resistant thermosetting resin to the solution; applying the liquid onto the basecoat layer; heating to cure the applied liquid; then irradiating light containing ultraviolet light to the cured shape. Irradiation of light containing ultraviolet light at the final step makes the hydrophobic section such as alkyl in the thermosetting resin having photo-resistant ingredients exposed to the surface of member in the backbone thereof decomposed and oxidized, thus hydrophilicized, while the photo-resistant ingredients structuring the backbone of the resin are not changed.

[0186]

In a method for manufacturing antifogging translucent member comprising a substrate, and a surface layer made of a hydrophilic photocatalyst, a hydrophilic material, and an anti-bacterial metal, the member having smooth surface layer even when the surface of substrate is irregular, having relatively high surface strength, and being able to maintain and recover the hydrophilicity for a long period is easily obtained by the steps of: forming a basecoat layer onto the surface of the substrate; mixing a photocatalyst sol and a solution containing an anti-bacterial metal ion; preparing a liquid by adding a photo-resistant thermosetting resin to the solution; applying the liquid onto the surface of the

substrate; heating to cure the applied liquid; then irradiating light containing ultraviolet light to thus cured shape.

[0187]

In a method for manufacturing antifogging translucent member comprising a substrate, and a surface layer made of a hydrophilic photocatalyst, a hydrophilic material, and a anti-bacterial metal, the member having a relatively high surface strength, and being able to maintain and recover the hydrophilicity for a long period is easily obtained by the steps of: preparing a liquid containing a photocatalyst sol and a photo-resistant thermosetting resin; applying the liquid onto the surface of the substrate; heating to cure the applied liquid; applying a solution containing an anti-bacterial metal ion onto thus cured shape; then irradiating light containing ultraviolet light to the shape. Irradiation of light containing ultraviolet light at the final step makes the hydrophobic section such as alkyl in the thermosetting resin having photo-resistant ingredients exposed to the surface of member in the backbone thereof decomposed and oxidized, thus hydrophilicized, while the photo-resistant ingredients structuring the backbone of the resin are not changed.

[0188]

In a method for manufacturing antifogging translucent member comprising a substrate, and a surface layer made of a hydrophilic photocatalyst and a hydrophilic material, the member having smooth surface layer even when the surface of substrate is irregular, having relatively high surface strength, and being able to maintain and recover the

hydrophilicity for a long period is easily obtained by the steps of: forming a basecoat layer onto the surface of the substrate; applying a liquid containing a photocatalyst sol and a photo-resistant thermosetting resin onto the surface of the basecoat layer; heating to cure the applied liquid; applying a solution containing an anti-bacterial metal ion onto thus cured shape; then irradiating light containing ultraviolet light to the shape.

[0189]

In a method for manufacturing antifogging translucent member comprising a substrate, and a surface layer made of a hydrophilic photocatalyst and a hydrophilic material, the member having relatively high surface strength, and being able to maintain and recover the hydrophilicity for a long period is easily obtained, independent of the heat resistance of mirror components such as silver mirror protective material owing to the application of heating and curing step at around 100℃ at the maximum, by the steps of: after fabricating a mirror, applying a liquid containing a photocatalyst sol and a photo-resistant thermosetting resin onto the surface of the mirror; heating to cure the applied liquid; then irradiating light containing ultraviolet light to thus cured shape.

[0190]

In a method for manufacturing antifogging translucent member comprising a substrate, and a surface layer made of a hydrophilic photocatalyst and a hydrophilic material, the member having smooth surface layer even when the substrate has irregular surface, having relatively high surface strength, and being able to maintain and recover the

hydrophilicity for a long period is easily obtained, independent of the heat resistance of mirror components such as silver mirror protective material owing to the application of heating and curing step at around 100℃ at the maximum, by the steps of: after fabricating a mirror, forming a basecoat layer onto the surface of the mirror; applying a liquid containing a photocatalyst sol and a photo-resistant thermosetting resin onto the basecoat layer; heating to cure the applied liquid; then irradiating light containing ultraviolet light to thus cured shape.

[0191]

In a method for manufacturing antifogging translucent member comprising a substrate, and a surface layer made of a hydrophilic photocatalyst and a hydrophilic material, the member having relatively high surface strength, and being able to maintain and recover the hydrophilicity for a long period is easily obtained by the steps of: applying a liquid containing a photocatalyst sol and a photo-resistant thermosetting resin onto the surface of a glass before fabricating a mirror; heating to cure the applied liquid; irradiating light containing ultraviolet light to thus cured shape; then fixing silver onto rear face of the shape using the silver mirror reaction.

[0192]

In a method for manufacturing antifogging translucent member comprising a substrate, and a surface layer made of a hydrophilic photocatalyst and a hydrophilic material, the member having smooth surface layer even when the substrate has surface irregularity, having relatively high surface strength, and being able to maintain and recover the

hydrophilicity for a long period is easily obtained by the steps of: forming a basecoat layer onto the surface of glass before fabricating a mirror; applying a liquid containing a photocatalyst sol and a photo-resistant thermosetting resin onto the basecoat layer; heating to cure the applied liquid; irradiating light containing ultraviolet light to thus cured shape; then fixing silver onto rear face of the shape using the silver mirror reaction.

[0193]

In a method for manufacturing antifogging translucent member comprising a substrate, and a surface layer made of a hydrophilic photocatalyst and a hydrophilic material, the member having relatively high surface strength, and being able to maintain and recover the hydrophilicity for a long period is easily obtained by the steps of: applying a liquid containing a photocatalyst sol and a photo-resistant thermosetting resin onto the surface of a glass before fabricating a mirror; heating to cure the applied liquid; fixing silver onto rear face of thus cured shape using the silver mirror reaction; then irradiating light containing ultraviolet light to the shape.

[0194]

In a method for manufacturing antifogging translucent member comprising a substrate, and a surface layer made of a hydrophilic photocatalyst and a hydrophilic material, the member having smooth surface layer even when the substrate has surface irregularity, having relatively high surface strength, and being able to maintain and recover the hydrophilicity for a long period is easily obtained by the

steps of: forming a basecoat layer onto the surface of a glass before fabricating a mirror; applying a liquid containing a photocatalyst sol and a photo-resistant thermosetting resin onto the basecoat layer; heating to cure the applied liquid; fixing silver onto rear face of thus cured shape using the silver mirror reaction; then irradiating light containing ultraviolet light to the shape.

[0195]

In a method for manufacturing antifogging translucent member comprising a substrate, and a surface layer made of a hydrophilic photocatalyst, a hydrophilic material, and an anti-bacterial metal, the member having relatively high surface strength, and being able to maintain and recover the hydrophilicity for a long period is easily obtained, independent of the heat resistance of mirror components such as silver mirror protective material owing to the application of heating and curing step at around 100℃ at the maximum, by the steps of: after fabricating a mirror, mixing a photocatalyst sol with a solution containing anti-bacterial metal ion; adding a photo-resistant thermosetting resin to the mixed solution, applying thus prepared solution onto the surface of the mirror; heating to cure the applied liquid; then irradiating light containing ultraviolet light to thus cured shape.

[0196]

In a method for manufacturing antifogging translucent member comprising a substrate, and a surface layer made of a hydrophilic photocatalyst, a hydrophilic material, and an anti-bacterial metal, the member having smooth surface layer even when the substrate has surface irregularity, having

relatively high surface strength, and being able to maintain and recover the hydrophilicity for a long period is easily obtained, independent of the heat resistance of mirror components such as silver mirror protective material owing to the application of heating and curing step at around 100℃ at the maximum, by the steps of: after fabricating a mirror, forming a basecoat layer on the surface of the mirror; mixing a photocatalyst sol with a solution containing anti-bacterial metal ion; adding a photo-resistant thermosetting resin to the mixed solution; applying thus prepared liquid onto the basecoat layer; heating to cure the applied liquid; then irradiating light containing ultraviolet light to thus cured shape.

[0197]

In a method for manufacturing antifogging translucent member comprising a substrate, and a surface layer made of a hydrophilic photocatalyst, a hydrophilic material, and an anti-bacterial metal, the member having relatively high surface strength, and being able to maintain and recover the hydrophilicity for a long period is easily obtained, independent of the heat resistance of mirror components such as silver mirror protective material owing to the application of heating and curing step at around 100℃ at the maximum, by the steps of: after fabricating a mirror, applying a liquid containing a photocatalyst sol and a photo-resistant thermosetting resin onto the surface of the mirror; heating to cure the applied liquid; applying a solution containing an anti-bacterial metal ion onto thus cured shape; then irradiating light containing ultraviolet light to the shape.

[0198]

In a method for manufacturing antifogging translucent member comprising a substrate, and a surface layer made of a hydrophilic photocatalyst and a hydrophilic material, the member having smooth surface layer even when the substrate has surface irregularity, having relatively high surface strength, and being able to maintain and recover the hydrophilicity for a long period is easily obtained, independent of the heat resistance of mirror components such as silver mirror protective material owing to the application of heating and curing step at around 100℃ at the maximum, by the steps of: after fabricating a mirror, forming a basecoat layer on the mirror; applying a liquid containing a photocatalyst sol and a photo-resistant thermosetting resin onto the basecoat layer; heating to cure the applied liquid; applying a solution containing an anti-bacterial metal ion onto thus cured shape; then irradiating light containing ultraviolet light to the shape.

[0199]

In a method for manufacturing antifogging translucent member comprising a substrate, and a surface layer made of a hydrophilic photocatalyst, a hydrophilic material, and an anti-bacterial metal, the member having relatively high surface strength, and being able to maintain and recover the hydrophilicity for a long period is easily obtained by the steps of: mixing a photocatalyst sol with a solution containing an anti-bacterial metal ion; adding a photo-resistant thermosetting resin to the mixture; applying thus prepared solution onto the surface of a glass before fabricating a mirror; heating to cure the applied solution;

irradiating light containing ultraviolet light to the cured shape; then fixing silver onto rear face of the shape using the silver mirror reaction.

[0200]

In a method for manufacturing antifogging translucent member comprising a substrate, and a surface layer made of a hydrophilic photocatalyst, a hydrophilic material, and an anti-bacterial metal, the member having smooth surface layer even when the substrate has surface irregularity, having relatively high surface strength, being able to maintain and recover the hydrophilicity for a long period, and having anti-bacterial property is easily obtained by the steps of: forming a basecoat layer on the surface of a glass before fabricating a mirror; mixing a photocatalyst sol with a solution containing an anti-bacterial metal ion; adding a photo-resistant thermosetting resin to the mixture; applying thus prepared solution onto the surface of the basecoat layer; heating to cure the applied solution; irradiating light containing ultraviolet light to thus cured shape; then fixing silver onto the rear face of the shape using the silver mirror reaction.

[0201]

In a method for manufacturing antifogging translucent member comprising a substrate, and a surface layer made of a hydrophilic photocatalyst, a hydrophilic material, and an anti-bacterial metal, the member having relatively high surface strength, and being able to maintain and recover the hydrophilicity for long period, and having anti-bacterial property is easily obtained by the steps of: applying a liquid containing a photocatalyst sol and a photo-resistant

thermosetting resin onto the surface of a glass before fabricating a mirror; heating to cure the applied liquid; applying a solution containing an anti-bacterial metal ion onto thus cured shape; irradiating light containing ultraviolet light to the shape; then fixing silver onto rear face of the shape using the silver mirror reaction.

[0202]

In a method for manufacturing antifogging translucent member comprising a substrate, and a surface layer made of a hydrophilic photocatalyst, a hydrophilic material, and an anti-bacterial metal, the member having smooth surface layer even when the substrate has surface irregularity, having relatively high surface strength, being able to maintain and recover the hydrophilicity for a long period, and having anti-bacterial property is easily obtained by the steps of: forming a basecoat layer onto the surface of a glass before fabricating a mirror; applying a liquid containing a photocatalyst sol and a photo-resistant thermosetting resin onto the basecoat layer; heating to cure the applied liquid; applying a solution containing an anti-bacterial metal ion onto thus cured shape; irradiating light containing ultraviolet light to the shape; then fixing silver onto rear face of the shape using the silver mirror reaction.

[0203]

In a method for manufacturing antifogging translucent member comprising a substrate, and a surface layer made of a hydrophilic photocatalyst, a hydrophilic material, and an anti-bacterial metal, the member having relatively high surface strength, being able to maintain and recover the

hydrophilicity for a long period, and having anti-bacterial property is easily obtained by the steps of: applying a liquid containing a photocatalyst sol and a photo-resistant thermosetting resin onto the surface of a glass before fabricating a mirror; heating to cure the applied liquid; fixing silver onto rear face of thus cured shape using the silver mirror reaction; applying a solution containing an anti-bacterial metal ion onto the surface of the shape; then irradiating light containing ultraviolet light to the shape. [0204]

In a method for manufacturing antifogging translucent member comprising a substrate, and a surface layer made of a hydrophilic photocatalyst, a hydrophilic material, and an anti-bacterial metal, the member having smooth surface layer even when the substrate has surface iregularity, having relatively high surface strength, being able to maintain and recover the hydrophilicity for a long period, and having anti-bacterial property is easily obtained by the steps of: forming a basecoat layer onto the surface of a glass before fabricating a mirror; applying a liquid containing a photocatalyst sol and a photo-resistant thermosetting resin onto the basecoat layer, heating to cure the applied liquid; fixing silver onto rear face of thus cured shape using the silver mirror reaction; applying a solution containing an anti-bacterial metal ion onto the shape; then irradiating light containing ultraviolet light to the shape. [0205]

When drying step is inserted after the step for forming the basecoat layer, the surface of substrate becomes further smooth during the application of coating liquid, which

allows the coating liquid to be further uniformly applied.

[0206]

When an antifogging translucent film made of a hydrophilic material containing a photocatalyst is attached to the substrate, a function for maintaining and recovering hydrophilic surface to the substrate for a long period is easily added.

[0207]

When an antifogging translucent film made of a hydrophilic material containing a photocatalyst is attached to the substrate via a binder, a function for maintaining and recovering hydrophilic surface to the substrate for a long period is easily added. In addition, the film adhesiveness is increased owing to the binder.

[0208]

In a method for manufacturing antifogging translucent member comprising a substrate, and surface layer made of a hydrophilic photocatalyst and a hydrophilic material, while the exposed surface is made only of the hydrophilic material, the member having high surface strength, and being able to maintain and recover the hydrophilicity for a long period is easily obtained by a method simpler than that using alkoxide by the steps of: applying a photocatalyst sol onto the surface of the substrate; firing the applied substrate; applying an amorphous material onto thus fired shape; then firing the shape again.

[0209]

In a method for manufacturing antifogging translucent member comprising a substrate, and a surface layer made of a hydrophilic photocatalyst and a hydrophilic material, while

the exposed surface is made only of the hydrophilic material, the firing step is needed only once, thus reducing processing cost by the steps of: applying a photocatalyst sol onto the surface of the substrate; applying an amorphous material onto the applied photocatalyst sol; then firing the applied substrate.

[0210]

In a method for manufacturing antifogging translucent member comprising a substrate, and a surface layer made of a hydrophilic photocatalyst, a hydrophilic material, and an anti-bacterial metal, while the exposed surface is made only of the hydrophilic material, the member having high surface strength, being able to maintain and recover the hydrophilicity for a long period, and having anti-bacterial property is easily obtained by a method simpler than that using alkoxide by the steps of: applying a mixed solution of a photocatalyst sol and an anti-bacterial metal ion onto the surface of the substrate; firing the applied substrate; applying an amorphous material onto thus fired shape; then firing again the applied substrate.

[0211]

In a method for manufacturing antifogging translucent member comprising a substrate, and a surface layer made of a hydrophilic photocatalyst, a hydrophilic material, and an anti-bacterial metal, while the exposed surface is made only of the hydrophilic material, the firing step is needed only once, thus reducing processing cost by the steps of: applying a mixture of a photocatalyst sol and a solution containing an anti-bacterial metal ion onto the surface of the substrate; applying an amorphous material onto the

applied mixed solution; then firing the applied substrate.

[0212]

In a method for manufacturing antifogging translucent member comprising a substrate, and a surface layer made of a hydrophilic photocatalyst, a hydrophilic material, and an anti-bacterial metal, while the exposed surface is made only of the hydrophilic material, the member having high surface strength, being able to maintain and recover the hydrophilicity for a long period, and having anti-bacterial property is easily obtained by a method simpler than that using alkoxide by the steps of: applying a photocatalyst sol onto the surface of the substrate; firing the applied substrate; applying an amorphous material onto thus fired shape; firing the applied shape again; applying a solution containing an anti-bacterial metal ion onto thus re-fired shape; then irradiating light containing ultraviolet light to the shape.

[0213]

In a method for manufacturing antifogging translucent member comprising a substrate, and a surface layer made of a hydrophilic photocatalyst, a hydrophilic material, and an anti-bacterial metal, while the exposed surface is made only of the hydrophilic material, the firing step is needed only once, thus reducing processing cost by the steps of: applying a photocatalyst sol onto the surface of the substrate; applying an amorphous material onto the photocatalyst sol layer; firing the applied substrate; applying a solution containing an anti-bacterial metal ion onto thus re-fired shape; then irradiating light containing ultraviolet light to the shape.

[0214]

In a method for manufacturing antifogging translucent member comprising a substrate, and a surface layer made of a hydrophilic photocatalyst, a hydrophilic material, and an anti-bacterial metal, while the exposed surface is made only of the hydrophilic material, the member having high surface strength, being able to maintain and recover the hydrophilicity for a long period, and having anti-bacterial property is easily obtained by a method simpler than that using alkoxide by the steps of: applying a photocatalyst sol onto the surface of the substrate; firing the applied substrate; applying an amorphous material onto thus fired shape; applying a solution containing an anti-bacterial metal ion onto the applied amorphous material; then firing the substrate again.

[0215]

In a method for manufacturing antifogging translucent member comprising a substrate, a surface layer made of a hydrophilic photocatalyst, a hydrophilic material, and an anti-bacterial metal, while the exposed surface is made only of the hydrophilic material, the firing step is needed only once, thus reducing processing cost by the steps of: applying a photocatalyst sol onto the surface of the substrate; firing the applied substrate; applying an amorphous material onto thus fired shape; applying a solution containing an anti-bacterial metal ion onto the applied amorphous material; then firing the substrate again.

[0216]

In a method for manufacturing antifogging translucent member comprising a substrate, and a surface layer made of a

hydrophilic photocatalyst, a hydrophilic material, and an anti-bacterial metal, while the exposed surface is made only of the hydrophilic material, the firing step is needed only once, thus reducing processing cost by the steps of: applying a photocatalyst sol onto the surface of the substrate; applying a solution containing an anti-bacterial metallic ion onto the applied photocatalyst sol layer; applying an amorphous material onto the applied anti-bacterial metallic ion layer; then firing the substrate.

[0217]

In a method for manufacturing antifogging translucent member comprising a substrate, and a surface layer made of a hydrophilic photocatalyst, a hydrophilic material, and an anti-bacterial metal, while the exposed surface is made only of the hydrophilic material, the member having high surface strength, being able to maintain and recover the hydrophilicity for a long period, and having anti-bacterial property is easily obtained by a method simpler than that using alkoxide by the steps of: applying a photocatalyst sol onto the surface of the substrate; firing the applied substrate; applying a solution containing an anti-bacterial metallic ion onto thus fired shape; applying an amorphous material onto the applied anti-bacterial metallic ion layer; then firing the substrate again.

[0218]

In a method for manufacturing antifogging translucent member comprising a substrate, and a surface layer made of a hydrophilic photocatalyst, a hydrophilic material, and an anti-bacterial metal, while the exposed surface is made only of the hydrophilic material, the member having high surface

strength, being able to maintain and recover the hydrophilicity for a long period, and having anti-bacterial property is easily obtained by a method simpler than that using alkoxide by the steps of: applying a photocatalyst sol onto the surface of the substrate; applying a solution containing an anti-bacterial metallic ion onto the applied photocatalyst sol layer; firing the applied substrate; applying an amorphous material onto thus fired shape; then firing the substrate again.

[0219]

By sending dry air to the surface of translucent member having a hydrophilic exposed surface and a means to sustain the hydrophilicity, the surface of member becomes difficult to reach supersaturation, thus further effectively preventing fogging.

[0220]

By irradiating ultraviolet light against the surface of translucent material having a hydrophilic exposed surface and a means to sustain the hydrophilicity, in the case that the means to sustain the hydrophilicity is a photocatalyst, the hydrophobicizing of surface is effectively prevented, thus preventing fogging.

[0221]

[Embodiments]

Concrete constituent of the present invention is described in the following referring to embodiments.

Hydrophilic exposed surface indicates a state that the member surface shows hydrophilicity to a degree of not allowing the formation of water droplet, and the state that the contact angle with water is extremely small. In

concrete terms, the angle of contact is less than 30 degrees, more preferably less than 10 degrees.

[0222]

Hydrophilic material is a material which shows extremely small contact angle with water under a condition that no component including both hydrophilic group and hydrophobic group of, for example, lower carboxylic acid exists on the surface thereof. Examples of that type of material are; inorganic crystalline oxide such as crystalline alumina, zirconia, titanium oxide, zinc oxide, strontium titanate, tungsten trioxide, ferric oxide, di-bismuth trioxide, and tin oxide; inorganic amorphous material such as glaze and glass; resin comprising Si-O bond or Si-N bond, including silicon resin and silazane resin; resin containing metal-oxygen bond such as Ti-O bond.

[0223]

Means sustaining hydrophilic exposed surface designates a means that can inhibit the exposed surface from hydrophobicization or can recover the hydrophilicity of once-hydrophobicized exposed surface. For example, a photocatalyst is preferably applied.

[0224]

As an antifogging translucent member comprising a hydrophilic exposed surface and a means to sustain the hydrophilic exposed surface, for example, the following-described two modes are applicable.

The one is a film-shaped antifogging translucent member comprising a hydrophilic exposed surface and a means to sustain the hydrophilic exposed surface.

In that case, an applicable mode when the means to

sustain the hydrophilic exposed surface is a photocatalyst is shown in Fig. 1.

Fig. 1 shows an antifogging translucent member comprising a hydrophilic film containing a photocatalyst.

[0225]

The other one is an antifogging translucent member comprising a substrate, and a surface layer having a hydrophilic exposed surface and a means to sustain the hydrophilic exposed surface.

In that case, applicable modes when the means to sustain the hydrophilic exposed surface is a photocatalyst are shown in Figs. 2 through 4.

Fig. 2 is for the case that the surface layer is formed by a hydrophilic photocatalyst. Fig. 3 is for the case that the surface layer is formed by a hydrophilic photocatalyst and a hydrophilic non-photocatalyst material. Fig. 4 is for the case that the surface layer is formed by a photocatalyst and a hydrophilic material, and the exposed surface is formed solely by the hydrophilic material.

[0226]

The photocatalyst described above designates a material which emits electrons and forms positive holes under irradiation of light having a specified wave length or shorter, thus being able to generate active oxygen. Among that type of materials, examples of the one having hydrophilicity are titanium oxide, zinc oxide, strontium titanate, tungsten trioxide, ferric oxide, di-bismuth trioxide, and tin oxide.

Examples of the irradiation source of light having a specific wave length or shorter are solar ray light,

fluorescent lamp, mercury lamp, incandescent lamp, xenon lamp, BLB lamp, metal halide lamp, iron luminescent lamp, bactericidal lamp.

[0227]

Material of substrate is arbitrary if only it has translucent property. Examples of that type of material are glass, translucent ceramics, and transparent resins.

[0228]

Electron acquiring metal is a metal such as Pt, Pd, Ag, Cu, Au, Ni, Co, and Fe, which has a small ionization tendency and which is likely reduced by itself.

[0229]

The following is the description of manufacturing method for an antifogging translucent member shown in Figs. 1 through 4. The first example is for an antifogging translucent member containing a photocatalyst, wherein the film made of a hydrophilic material is a thermosetting resin (siloxane resin) and the photocatalyst is anatase titanium oxide.

The method for manufacturing an antifogging translucent member comprises the steps of: preparing a mixed solution by adding siloxane resin to anatase titanium oxide sol; forming a dilute solution of the mixed solution using a solvent; preparing a liquid by further adding curing agent to the diluted solution; heating to cure the liquid by pouring it into a mold; separating thus formed shape from the mold to obtain an intermediate member; irradiating light including ultraviolet light against the surface of the intermediate member, thus oxidizing (carboxylation) or decomposing the R section comprising alkyl in siloxane resin layer formed and

exposed to the surface. The steps are expressed by the formula (1).

[0230]

Formula (1)

[0231]

The anatase titanium oxide sol is preferably fully dispersed in a suspension. To do this, the dispersion is done in acidic or alkaline state because the anatase titanium oxide has an isoelectric point at pH 6.5. The dispersion medium is arbitrarily selected, and favorable one is water and alcohol which are safe and easy for use.

[0232]

The reason of adding diluent after adding siloxane resin to anatase titanium oxide is to reduce the viscosity of the prepared liquid and to improve flowability of the liquid for charging the liquid into the mold. Accordingly, any kind of diluent is applicable if only the object is attained. Water and alcohol are safe and easy for use as the diluent. If the liquid has a satisfactorily low viscosity level without adding diluent, the diluent is not necessarily added.

[0233]

A liquid for applying onto substrate is prepared without inducing coagulation of the suspension by the steps of: adding siloxane resin to anatase titanium oxide sol; adding a diluent; then adding a curing agent.

[0234]

The following is an example of an antifogging translucent member comprising a film made of the hydrophilic

material shown in Fig. 1, which film contains a photocatalyst, wherein the film made of the hydrophilic material is a thermosetting resin (siloxane resin), and the photocatalyst is anatase titanium oxide, and further an anti-bacterial metal is added to the film.

[0235]

In that case, the method for manufacturing an antifogging translucent member comprises the steps of: mixing a solution containing an anti-bacterial metal ion to anatase titanium oxide sol; preparing a mixed solution by further adding siloxane resin; forming a dilute solution of the mixed solution using a solvent; preparing a liquid by further adding curing agent to the diluted solution; heating to cure the liquid by pouring it into a mold; separating thus formed shape from the mold to obtain an intermediate member; irradiating light including ultraviolet light against the surface of the intermediate member, thus oxidizing (carboxylation) or decomposing the R section comprising alkyl in siloxane resin layer formed and exposed to the surface. The steps are expressed by the formula (1).

[0236]

Preferable solution containing anti-bacterial metal ion is a solution of soluble anti-bacterial metallic compound such as silver lactate, silver nitrate, silver sulfate, cuprous sulfate, cuprous acetate, cupric acetate, cupric sulfate, cupric chloride, cupric borate, cupric nitrate, zinc chloride, zinc sulfate, zinc iodide, zinc borate, and zinc nitrate, which solution is readily mixed.

Any kind of solvent of solution containing anti-bacterial metal ion is basically applicable. Water and

alcohol are safe and easy for use as the solvent. Use of the same kind with anatase titanium oxide sol is preferable owing to easiness of mixing.

[0237]

In a step for mixing anatase titanium oxide sol with a solution containing an anti-bacterial metal ion, pH of the solution containing the anti-bacterial metal ion is preferably adjusted to almost the same with pH of the anatase titanium oxide sol. The reason is that the change in pH of the anatase titanium oxide sol is smaller, thus the pH of the solution containing the anti-bacterial meal ion does not significantly degrade the dispensability of the anatase titanium oxide sol in the suspension.

[0238]

After mixing the anatase titanium oxide sol with the solution containing the anti-bacterial metal ion, a light containing ultraviolet light may be irradiated thereto. Irradiation of light containing ultraviolet light makes the anti-bacterial metal ion photoreduce to fix onto the anatase titanium oxide particles, so the rate of gradual release of the anti-bacterial metal ion is suppressed, thus sustaining the antibacterial action for further long period.

[0239]

Among various kinds of anti-bacterial metals, silver is most preferable because silver does not give change in the rate of oxidization (presumably carboxylic oxidization) or of decomposition reaction (formula (1)) on R section made of alkyl and the like in the siloxane resin layer.

[0240]

Next example is for the antifogging translucent member

comprising a film made of the hydrophilic material shown in Fig. 1 containing a photocatalyst, wherein the film made of the hydrophilic material is a thermoplastic resin, and wherein the photocatalyst is anatase titanium oxide.

[0241]

In that case, the manufacturing method comprises the steps of: applying anatase titanium oxide particles onto the surface of an injection molding die; conducting injection molding using a thermoplastic compound to prepare an intermediate member; and giving oxidization (Presumably carboxylic oxidization) or decomposition (formula (1)) on R section made of alkyl in the siloxane resin layer which is formed and exposed on the surface of the intermediate member.

[0242]

The next example is the method for manufacturing antifogging translucent member comprising a film made of a hydrophilic material shown in Fig. 1 containing a photocatalyst, wherein the film made of hydrophilic material is a thermoplastic resin, and the photocatalyst is anatase titanium oxide, further an anti-bacterial metal is added.

[0243]

In that case, the manufacturing method comprises the steps of: applying solution containing an anti-bacterial metal ion onto the anatase titanium oxide particles and conducting photo-reduction-fixing to prepare mixed particles; applying thus prepared mixed particles onto the surface of injection molding die; conducting injection molding using a thermoplastic resin to obtain an intermediate member; and giving oxidization (presumably

carboxylic oxidization) or decomposition (formula (1)) on R section made of alkyl and the like in the siloxane resin layer which is formed and exposed on the surface of the intermediate member.

[0244]

Next example for the antifogging translucent member comprising a substrate shown in Fig. 2, and a surface layer made of a hydrophilic photocatalyst, wherein the substrate is quartz glass, and wherein the hydrophilic photocatalyst is anatase titanium oxide.

In that case, it is preferable to apply a sequent order of steps: applying precursor of anatase titanium oxide such as titanium alkoxide onto the surface of substrate; then firing the work.

[0245]

Precursor of anatase titanium oxide is a material which is converted into anatase titanium oxide after firing, such as organic titanium salt such as titanium alkoxide, and inorganic titanium salt such as titanium sulfate. Use of that type of precursor of anatase titanium oxide is preferable because it is applicable uniformly onto the substrate. In addition, since the precursor changes into amorphous titanium oxide, and anatase titanium crystals are formed after the substrate is uniformly covered, so it is difficult to generate micropores having a size of 0.2 microns or more, and translucent property is not lost caused from light dispersion even when the thickness of the surface layer is increased to longer than the visible light wave length. Therefore, it is preferable for further effectively preventing the hydrophobicization by adding lots of means to

sustain the exposed area of hydrophilicity.

[0246]

An example of the step for applying a precursor of anatase titanium oxide onto a quartz glass is described below for the case of titanium tetraoxide ($(C_2H_5O)_4Ti$) which is a titanium alkoxide as the precursor of anatase titanium oxide.

[0247]

First, the coating solution is prepared by adding a diluent and hydrochloric acid to titanium tetraoxide.

A preferable diluent is alcohol such as ethanol and propanol for its easiness of handling. The diluent preferably contains as small amount of water as possible. If a large quantity of water is contained, hydrolysis of metallic alkoxide is explosively accelerated to cause the crack generation.

Addition of hydrochloric acid is for preventing crack generation in succeeding drying step and heat treatment step.

[0248]

Then, the coating solution is applied onto the substrate. A preferable applying method of metallic alkoxide is flow coating method because of its simplicity. Flow coating is preferably conducted in dry air. The dry air does not mean the one free of water but means less water content than ordinary atmospheric air. If the coating is done in ordinary atmospheric air, hydrolysis is excessively accelerated by the moisture in air so that the control of film thickness becomes difficult. For the case of titanium tetraethoxide, preferable coating weight per single cycle of

application is 100 μg of titanium oxide per cm^2 or less from the point of prevention of crack generation.

[0249]

After then, drying in dry air for 1 to 10 min provides an amorphous titanium oxide film. The principle of titanium oxide formation during the above-described steps is the following. Titanium tetraethoxide as the starting material reacts with a slight amount of water in dry air mainly during the flow coating step, and is hydrolyzed to yield titanium hydroxide. The titanium hydroxide begins dehydration and condensation during drying step to yield amorphous titanium oxide on the substrate. The titanium oxide particles generated have a size of about several nanometers and are high purity. Therefore, these particles are sintered at lower temperature than the sintering temperature of this titanium oxide.

[0250]

When thus obtained applied material is fired at 400℃ or above, amorphous titanium oxide is crystallized to provide an antifogging translucent member having an anatase titanium oxide film which has dense and hydrophilic structure.

[0251]

Next example is for an antifogging translucent member comprising a substrate shown in Fig. 2, and a surface layer made of hydrophilic photocatalyst thereon, wherein the substrate is made of soda glass, and the hydrophilic photocatalyst is made of anatase titanium oxide.

A preferable manufacturing method comprises the steps of; applying a precursor of silica glass such as silicon

alkoxide onto the soda glass; applying a precursor of anatase titanium oxide such as titanium alkoxide onto the applied precursor of silica glass; then firing these applied compounds.

[0252]

It is preferable to insert a high purity silica layer between the substrate and the surface layer because the alkali ingredients in the soda glass diffuse to the surface to attach to the active centers of anatase titanium oxide, thus effectively preventing degradation of photocatalytic activity.

When the substrate includes alkali metal such as sodium and potassium, and alkali earth metal such as magnesium and calcium, the insertion of a high purity silica layer between the substrate and the surface layer is effective equal to the case of soda glass substrate.

[0253]

The step for applying the precursor of silica glass such as silicon alkoxide onto the soda glass is performed in the following.

The coating solution is prepared by adding a diluent, water, and hydrogen chloride to a silicon alkoxide such as tetraethoxysilane ($Si(OC_2H_5)_4$).

The reason of adoption of water addition is that alkoxide of silicon is stable compared with alkoxide of transient metal such as titanium, and hardly induces hydrolysis, so the hydrolysis is needed to be accelerated.

Since the prepared coating solution generates heat caused by the added water, it is preferable to conduct flow coating onto the substrate after allowing the prepared

coating solution to stand for about 1 hr.

[0254]

Next example is for an antifogging translucent member comprising a substrate shown in Fig. 2, and a surface layer made of a hydrophilic photocatalyst thereon, wherein the substrate is a mirror, and the hydrophilic photocatalyst is anatase titanium oxide.

The method for manufacturing the member comprises the steps of: applying a precursor of anatase titanium oxide such as titanium alkoxide onto the surface of glass before fabricating the mirror; firing the applied glass; applying silver onto rear surface using the silver mirror reaction; then protecting the silver mirror section with a resin composition and the like.

[0255]

An alternative method comprises the steps of: applying a precursor of silicon glass such as silicon alkoxide onto the surface of glass before fabricating the mirror; applying a precursor of anatase titanium oxide such as titanium alkoxide on the applied precursor of silicon glass; firing the applied glass; applying silver on rear surface of the glass using silver mirror reaction; then protecting the silver mirror section with a resin composition and the like. According to the alternative method, the surface layer is fixed via the high purity silica layer even when the glass before fabricating the mirror contains alkali metal such as sodium and potassium and alkali earth metal such as magnesium and calcium, so the diffusion of these ingredients to the surface layer is prevented, thus effectively preventing the attaching of these ingredients to the active

centers of anatase titanium oxide and preventing degradation of photocatalytic activity.

[0256]

If the protective material at the silver mirror section uses a heat resistant member (for 400℃ or above), a method described below is applicable.

The method comprises the steps of: fabricating a mirror; applying a precursor of anatase titanium oxide such as titanium alkoxide onto the surface of the mirror; then firing the applied mirror. Alternatively, the method comprises the steps of: fabricating the mirror; applying a precursor of silica glass such as silicon alkoxide onto the surface of the mirror; applying a precursor of anatase titanium oxide such as titanium alkoxide onto the applied precursor of silica glass; then firing the applied mirror.

[0257]

Next example is for an antifogging translucent member comprising a surface layer made of a hydrophilic photocatalyst, wherein the substrate is quartz glass, and the hydrophilic photocatlyst is anatase titanium oxide, and wherein further an anti-bacterial metal is added.

The method for manufacturing the member comprises the steps of: applying a precursor of anatase titanium oxide such as titanium alkoxide onto the surface of the substrate; firing the applied substrate; applying a solution containing the anti-bacterial metal ion onto the fired substrate; then irradiating light including ultraviolet light onto the substrate.

[0258]

Next example is for an antifogging translucent member,

wherein the substrate is made of soda glass, the hydrophilic photocatalyst is made of anatase titanium oxide, and the anti-bacterial metal is added.

A preferable method for manufacturing the member comprises the steps of: applying a precursor of silica glass such as silicon alkoxide onto the soda glass; applying a precursor of anatase titanium oxide such as tatanium alkoxide onto the applied precursor of silica glass; firing the applied substrate; applying a solution containing the anti-bacterial metal ion onto the surface of the substrate; irradiating light containing ultraviolet light onto the substrate.

[0259]

Next example is for an antifogging translucent member, wherein the substrate is a mirror, the hydrophilic photocatalyst is anatase titanium oxide, and further an anti-bacterial metal is added.

A method for manufacturing the member comprises the steps of: applying a precursor of anatase titanium oxide such as titanium alkoxide onto the surface of a glass before fabricating a mirror; firing the applied glass; applying a solution containing an anti-bacterial metal ion onto the fired glass; irradiating light containing ultraviolet light onto the fired glass; applying silver onto rear surface of the glass using the silver mirror reaction; then protecting the silver mirror section with a resin composition and the like.

An alternative method for manufacturing the member comprises the steps of: applying a precursor of anatase titanium oxide such as titanium alkoxide onto the surface of

a glass before fabricating a mirror; firing the applied glass; applying silver onto rear surface of the glass using silver mirror reaction; protecting the silver mirror section with a resin composition and the like; applying a solution containing an anti-bacterial metal ion onto the protective coating; then irradiating light containing ultraviolet light to the glass.

In the above-given two example methods, firstly a high purity silica layer may be formed on the glass surface.

[0260]

When the protective material at the silver mirror section uses a heat resistant member (at 400℃ or above), further the following manufacturing method is applicable.

The method comprises the steps of: fabricating a mirror; applying a precursor of anatase titanium oxide such as titanium alkoxide onto the surface of the mirror; firing the applied mirror; applying a solution containing an anti-bacterial metal ion onto the surface of the fired mirror; irradiating light including ultraviolet light onto the applied mirror. Or alternatively, the method comprises the steps of: fabricating a mirror; applying a precursor of silica glass such as silicon alkoxide onto the surface of the mirror; applying a precursor of anatase titanium oxide such as titanium alkoxide onto the applied silica glass; firing the applied mirror; applying a solution containing an anti-bacterial meal ion on to the surface of fired mirror; then irradiating light containing ultraviolet light onto the mirror.

[0261]

Next example is an antifogging translucent member

comprising a substrate shown in fig. 3, and a surface layer made of a hydrophilic photocatalyst and a hydrophilic material thereon, wherein the substrate is glass, the hydrophilic photocatalyst is made of anatase titanium oxide, and the hydrophilic material is made of a hydrophilicized thermosetting resin (siloxane resin).

A method for manufacturing the member comprises the steps of: preparing a mixed solution of anatase titanium oxide containing a siloxane resin; preparing a diluted solution of the mixture using a solvent; preparing a liquid by further adding a curing agent to the diluted solution; applying thus prepared liquid onto the surface of the substrate; heating to cure the applied substrate to obtain an intermediate member; irradiating light containing ultraviolet light onto the surface of the intermediate member; thus oxidizing or decomposing the R section structured by alkyl and the like in the siloxane resin layer which is exposed to the surface (according to formula (1)).

[0262]

The step for applying the liquid onto the surface of substrate is basically arbitrary method. A relatively simple method for applying the liquid includes spray coating method and roll coating method.

[0263]

An alternative method comprises the steps of: applying a mixed solution of siloxane resin and curing agent onto the glass substrate to form a basecoat layer; preparing a mixed liquid of anatase titanium oxide and added amount of siloxane resin; dilution the mixed liquid with a solvent to prepare a diluted liquid; further adding curing agent to the

diluted liquid to prepare a liquid; applying thus prepared liquid onto the basecoat layer; heating to cure the applied liquid to obtain an intermediate member; irradiating light containing ultraviolet light to the surface of the intermediate member, thus oxidizing or decomposing the R section made of alkyl and the like in siloxane resin layer formed on and exposed to the surface in accordance with formula (1).

[0264]

Figs. 5(a) through (c) show the result of Auger spectrometry giving element analysis of the intermediate member in cross sectional direction. The solvent used for dispersing the anatase titanium oxide was nitric acid, and the heating and curing treatment was carried out at 150℃. As seen in Fig. 5(a), Si, C, N, O were observed on the surface of the specimen, but no Ti was observed. In Fig. 5(b), however, Si, C, N, O, and also Ti were observed at 20 nm below the uppermost surface. The place of 200 nm below the uppermost surface is a layer consisting only of siloxane resin, where only Si, C, and O which are the structural ingredients of the layer were observed (Fig. 5(a)). That is, at uppermost surface of the intermediate member prepared by the manufacturing method described above, a single layer consisting only of siloxane resin was formed.

By irradiating light containing ultraviolet light against the intermediate member, the R section comprising alkyl and the like in siloxane resin layer formed on and exposed to the surface is oxidized or decomposed by the action of active oxygen generated from anatase titanium oxide, and is hydrophilicized.

[0265]

Light containing ultraviolet light is a light which contains a light having a short wave length to a degree of having sufficient energy to excite electrons from valence band to conduction band in a material having photocatalytic function. In the case of anatase titanium oxide, irradiation is conducted using a light containing light less than 400 nm of wave length.

[0266]

In that case, decomposition and oxidization proceed under a condition that the weight of photocatalyst against the weight sum of photocatalyst in the surface layer and siloxane resin is in a range of from 5% to 95%, more preferably from 5% to 10%, with only irradiating light containing ultraviolet light for a short time against the hydrophobic organic ingredients existing on the resin surface with sufficient film strength while sustaining the high film strength. As a result, hydrophilicization is readily realized. Furthermore, the active oxygen generated by photocatalyst enhances the effect of deodorization and anti-bacterial property.

[0267]

Next example is for an antifogging translucent member comprising a substrate shown in Fig. 3 and a surface layer made of a hydrophilic photocatalyst and a hydrophilic material, wherein the substrate is made of a resin, the hydrophilic photocatalyst is made of anatase titanium oxide, and the hydrophilic material is a hydrophilicized thermosetting resin (siloxane resin).

A method for manufacturing the member comprises the

steps of: preparing a mixed solution of anatase titanium oxide containing siloxane resin; preparing a diluted solution of the mixture using a solvent; preparing a liquid by further adding a curing agent to the diluted solution; applying thus prepared liquid onto the surface of the substrate; heating to cure the applied substrate to obtain an intermediate member, irradiating light containing ultraviolet light onto the surface of the intermediate member; thus oxidizing or decomposing the R section structured by alkyl and the like in the siloxane resin layer which is exposed to the surface (according to formula (1)).

An alternative method for manufacturing the member comprises the steps of: applying a mixed solution of siloxane resin and a curing agent onto the surface of the substrate; preparing a mixed solution of anatase titanium oxide by adding siloxane resin; preparing diluted solution of the mixture using a solvent; preparing a liquid by further adding a curing agent to the diluted solution; applying thus prepared liquid onto the basecoat layer; of the substrate; heating to cure the applied layers to obtain an intermediate member; irradiating light containing ultraviolet light onto the surface of the intermediate member; thus oxidizing or decomposing then R section structured by alkyl and the like in the siloxane resin layer which is exposed to the surface (according to formula (1)).

[0268]

The step for heating to cure may be conducted at a low temperature below 100℃ for a long period, or may be conducted at 100℃ or above and below the heat resistant temperature of the basecoat layer for a short period.

Generally on the surface layer, photocatalyst has heavier specific gravity than resin, it is preferable to conduct heating and curing at 100℃ or above and below the heat resistant temperature of the substrate and the basecoat layer because the photocatalyst concentrates the upper layer section, and because the time for hydrophilicization step is shortened by irradiating light containing ultraviolet light onto the surface of the intermediate member, thus oxidizing or decomposing the R section structured by alkyl and the like in the siloxane resin layer which is exposed to the surface (according to formula (1)).

[0269]

Next example is for an antifogging member comprising a substrate shown in Fig. 3 and a surface layer made of a hydrophilic photocatalyst and a hydrophilic material, wherein the substrate is made of a resin, the hydrophilic photocatalyst is made of anatase titanium oxide, and the hydrophilic material is a hydrophilicized thermosetting resin (siloxane resin), further an anti-bacterial metal is added.

A method for manufacturing the member comprises the steps of: preparing a mixed solution of anatase titanium oxide containing an anti-bacterial metal ion; preparing a mixed liquid by further adding siloxane resin; preparing a diluted solution of the mixture using a solvent; preparing a liquid by further adding a curing agent to the diluted solution; applying thus prepared liquid onto the surface of the substrate; heating to cure the applied substrate to obtain an intermediate member; irradiating light containing ultraviolet light onto the surface of the intermediate

member; thus oxidizing or decomposing the R section structured by alkyl and the like in the siloxane resin layer which is exposed to the surface (according to formula (1)).

An alternative method for manufacturing the member comprises the steps of: preparing a mixed solution of anataase titanium oxide by adding siloxane resin; diluting the mixed solution using a solvent; preparing a liquid by adding a curing agent to the diluted solution; applying the mixed solution onto the surface of the substrate; heating to cure the applied substrate; applying an anti-bacterial meal ion onto the surface; irradiating light containing ultraviolet light to obtain an intermediate member, thus oxidizing or decomposing the R section structured by alkyl and the like in the siloxane resin layer which is exposed to the surface (according to formula (1)).

Still other method for manufacturing the member comprises the steps of: preparing a mixed solution of anatase titanium oxide by adding siloxane resin; diluting the mixed solution using a solvent; preparing a diluted solution using a solvent; preparing a liquid by adding a curing agent further to the diluted solution; applying the mixed solution onto the surface of the substrate; heating to cure the applied substrate to obtain an intermediate material; irradiating light containing ultraviolet light to obtain an intermediate member, thus oxidizing or decomposing the R section structured by alkyl and the like in the siloxane resin layer which is exposed to the surface (according to formula (1)); applying a solution containing an anti-bacterial metal ion; then irradiating light containing ultraviolet light.

These three types of methods may further employ a basecoat layer.

[0270]

Next example is for an antifogging member comprising a substrate shown in Fig. 3 and a surface layer made of a hydrophilic photocatalyst and a hydrophilic material, wherein the substrate is a mirror, the hydrophilic photocatalyst is made of anatase titanium oxide, and the hydrophilic material is a hydrophilicized thermosetting resin (siloxane resin). In that case, heat treatment temperature may be a low level, so even the surface layer is formed after fabricating the mirror, the heat resistivity of the protective material of silver mirror section is arbitrarily selected.

[0271]

A method for manufacturing the member comprises the steps of: preparing a mirror; preparing a mixed solution of anatase titanium oxide containing anatase titanium oxide sol; preparing a diluted solution of the mixture using a solvent; preparing a liquid by further adding a curing agent to the diluted solution; applying thus prepared liquid onto the surface of the mirror; heating to cure the applied mirror to obtain an intermediate member; irradiating light containing ultraviolet light onto the surface of the intermediate member; thus oxidizing or decomposing the R section structured by alkyl and the like in the siloxane resin layer which is exposed to the surface (according to formula (1)).

An alternative method for manufacturing the member comprises the steps of: applying the mixed solution of

siloxane resin and a curing agent onto the surface of the mirror to form a basecoat layer; preparing a mixed solution of anatase titanium oxide by adding siloxane resin; diluting the mixed solution using a solvent; preparing a liquid by adding a curing agent to the diluted solution; applying the mixed solution onto the basecoat layer; heating to cure the applied layers to obtain an intermediate member; irradiating light containing ultraviolet light to obtain an intermediate member, thus oxidizing or decomposing the R section structured by alkyl and the like in the siloxane resin layer which is exposed to the surface (according to formula (1)). [0272]

Still other method for manufacturing the member comprises the steps of: preparing a mixed solution of anatase titanium oxide by adding siloxane resin; diluting the mixed solution using a solvent; preparing a liquid by adding a curing agent further to the diluted solution; applying the mixed solution onto the surface of the mirror; heating to cure the applied substrate to obtain an intermediate material; irradiating light containing ultraviolet light to the surface of thus obtained intermediate member, thus oxidizing or decomposing the R section structured by alkyl and the like in the siloxane resin layer which is exposed to the surface (according to formula (1)); applying silver onto rear surface of the mirror by silver mirror reaction; then protecting the silver mirror section by a resin composition and the like.

Still further method for manufacturing the member comprises the steps of: preparing a mixed solution of anatase titanium oxide by adding siloxane resin; diluting

the mixed solution using a solvent; preparing a liquid by adding a curing agent further to the diluted solution; applying the mixed solution onto the surface of a glass before fabricating a mirror; heating to cure the applied substrate to obtain an intermediate material; applying silver onto rear surface by silver mirror reaction; protecting the silver mirror section by a resin composition and the like; irradiating light containing ultraviolet light to the surface, thus oxidizing or decomposing the R section structured by alkyl and the like in the siloxane resin layer which is exposed to the surface (according to formula (1)). These two types of methods may further employ a basecoat layer. [0273]

Next example is for an antifogging member comprising a surface layer made of a hydrophilic photocatalyst and a hydrophilic material, wherein the substrate is a mirror, the hydrophilic photocatalyst is made of anatase titanium oxide, the hydrophilic material is a hydrophilicized thermosetting resin (siloxane resin), and an anti-bacterial metal is added.

A method for manufacturing the member comprises the steps of: preparing a mirror; preparing a mixed solution of anatase titanium oxide sol containing anti-bacterial metal ion; preparing a mixed liquid by further adding siloxane resin to thus prepared mixed solution; preparing a diluted solution of the mixture using a solvent; preparing a liquid by further adding a curing agent to the diluted solution; applying thus prepared liquid onto the surface of the mirror; heating to cure the applied mirror to obtain an intermediate member; irradiating light containing

ultraviolet light onto the surface of the intermediate member, thus oxidizing or decomposing the R section structured by alkyl and the like in the siloxane resin layer which is exposed to the surface (according to formula (1)).

An alternative method for manufacturing the member comprises the steps of: fabricating a mirror; preparing a mixed solution of anatase titanium oxide sol containing siloxane resin; diluting the mixed solution using a solvent; preparing a liquid by adding further a curing agent to thus prepared diluted liquid; applying liquid onto the surface of the mirror; heating to cure the applied layers; applying a solution containing an anti-bacterial metal ion onto the surface of the cured mirror; irradiating light containing ultraviolet light to obtain an intermediate member; then irradiating light containing ultraviolet light to the surface of the intermediate member, thus oxidizing or decomposing the R section structured by alkyl and the like in the siloxane resin layer which is exposed to the surface (according to formula (1)).

An alternative method for manufacturing the member comprises the steps of: fabricating a mirror; preparing a mixed solution of anatase titanium oxide sol containing an anti-bacterial metal ion; preparing a liquid by further adding siloxane resin to the mixed solution; diluting the mixed solution using a solvent; preparing a liquid by further adding a curing agent to thus prepared diluted liquid; applying liquid onto the surface of the mirror; heating to cure the applied layers to obtain an intermediate member; irradiating light containing ultraviolet light to the intermediate member to obtain an intermediate member,

thus oxidizing or decomposing the R section structured by alkyl and the like in the siloxane resin layer which is exposed to the surface (according to formula (1)); applying a solution containing an anti-bacterial metal ion; then irradiating light containing ultraviolet light.

An alternative method for manufacturing the member comprises the steps of; preparing a mixed solution of anatase titanium oxide sol containing an anti-bacterial metal ion; preparing a liquid by further adding siloxane resin to the mixed solution; diluting the mixed solution using a solvent; preparing a liquid by further adding a curing agent to thus prepared diluted liquid; applying liquid onto the surface of the mirror; heating to cure the applied layers to obtain an intermediate member; irradiating light containing ultraviolet light to the intermediate member, thus oxidizing or decomposing the R section structured by alkyl and the like in the siloxane resin layer which is exposed to the surface (according to formula (1)); applying silver to rear surface of the mirror by silver mirror reaction; then protecting the silver mirror section using a resin composition and the like.

An alternative method for manufacturing the member comprises the steps of: preparing a mixed solution of anatase titanium oxide sol containing siloxane resin; diluting the mixed solution using a solvent; preparing a liquid by further adding a curing agent to thus prepared diluted solution; applying the liquid onto the surface of a glass before fabricating a mirror; heating to cure the applied layers; applying a solution containing an anti-bacterial metal ion onto the surface of thus cured

shape; irradiating light containing ultraviolet light to the applied liquid to obtain an intermediate member; irradiating light containing ultraviolet light to the intermediate member, thus oxidizing or decomposing the R section structured by alkyl and the like in the siloxane resin layer which is exposed to the surface (according to formula (1)); applying silver to rear surface of the mirror using the silver mirror reaction; then protecting the silver mirror section using a resin composition and the like.

An alternative method for manufacturing the member comprises the steps of: preparing a mixed solution of anatase titanium oxide sol containing siloxane resin; diluting the mixed solution using a solvent; preparing a liquid by further adding a curing agent to thus prepared diluted solution; applying the liquid onto the surface of a glass before fabricating a mirror; heating to cure the applied layers to obtain an intermediate member; irradiating light containing ultraviolet light to the surface of the intermediate member, thus oxidizing or decomposing the R section structured by alkyl and the like in the siloxane resin layer which is exposed to the surface (according to formula (1)); applying a solution containing an anti-bacterial metal ion onto the surface; irradiating light containing ultraviolet light; applying silver to rear surface of the mirror; then protecting the silver mirror section using a resin composition and the like.

An alternative method for manufacturing the member comprises the steps of: preparing a mixed solution of anatase titanium oxide sol containing siloxane resin; diluting the mixed solution using a solvent; preparing a

liquid by further adding a curing agent to thus prepared diluted solution; applying the liquid onto the surface of a glass before fabricating a mirror; heating to cure the applied layers to obtain an intermediate member; irradiating light containing ultraviolet light to the surface of the intermediate member, thus oxidizing or decomposing the R section structured by alkyl and the like in the siloxane resin layer which is exposed to the surface (according to formula (1)); applying silver to rear surface of the mirror by the silver mirror reaction; protecting the silver mirror section using a resin composition and the like; then applying a solution containing an anti-bacterial metal ion to the surface.

The seven types of methods may further employ a basecoat layer.

[0274]

Advantage of Fig. 3 is to form the surface layer at a low temperature at around 100℃. As a result, the surface layer is able to be formed on an existing mirror and glass using either one of methods described above.

Similar effect is expected when the film of Fig. 1 is attached to an existing mirror and glass.

[0275]

Next example is for an antifogging translucent member comprising a substrate shown in Fig. 4, and a surface layer made of a photocatalyst and a hydrophilic material, wherein the exposed surface is made only of a hydrophilic material, and wherein the substrate is made of glass, the hydrophilic photocatalyst is also made of glass, the photocatalyst is made of anatase titanium oxide.

An advantage of the structure of Fig. 4 is that the surface is glass which is harder than resin and that the exposed surface is dense even when the starting material of photocatalyst is powder. If, however, the particle size of the powder is too coarse, the effect to sustain and recover the hydrophilic surface using photocatalyst degrades. Accordingly, the particle size is preferably at 0.3 μm or less.

A method for manufacturing the member under the condition comprises the steps of; applying anatase titanium oxide sol onto the glass substrate; firing the applied sol; applying glass frit; then re-firing the applied substrate.

An alternative method comprises the steps of: applying anatase titanium oxide sol onto the glass substrate; applying glass frit onto the anatase titanium oxide sol coating; then firing them.

[0276]

Next example is for an antifogging translucent member comprising a substrate shown in Fig. 4, a surface layer made of a photocatalyst and a hydrophilic material, wherein the exposed surface is made solely of a hydrophilic material; wherein the substrate is glass, the hydrophilic photocatalyst is also glass, the photocatalyst is made of anatase titanium oxide, and an anti-bacterial metal is added.

A method for manufacturing the member comprises the steps of: preparing a mixed solution of anatase titanium oxide sol containing anti-bacterial metal ion; applying the mixed solution onto the surface of the glass substrate; firing the applied substrate; applying glass frit onto the

applied mixed solution; applying glass frit onto the applied mixed solution; then firing them again.

An alternative method for manufacturing the member comprises the steps of: preparing a mixed solution of anatase titanium oxide sol containing an anti-bacterial metal ion, applying the solution onto the glass substrate; firing the applied substrate; applying glass frit to the substrate; firing them.

An alternative method for manufacturing the member comprises the steps of: applying anatase titanium oxide sol onto the glass substrate; firing the applied substrate; applying glass frit onto thus fired shape; re-frying them; applying a solution containing metal ion onto the surface of the shape; then irradiating light containing ultraviolet light.

An alternative method for manufacturing the member comprises the steps of: preparing a mixed solution of anatase titanium oxide sol containing anti-bacterial metal ion; applying the mixed solution onto the glass substrate; applying glass frit onto the applied mixed solution; firing them; applying a solution containing metal ion onto the surface; then irradiating light containing ultraviolet light.

[0277]

It is preferable that the surface of translucent member of Figs. 1 through 4 is further provided with a means to generate heat because the temperature rise of the surface of the member prevents the precipitation of water vapor molecules onto the surface. A method for this is to locate transparent electrode such as that of tin oxide onto the

surface layer.

In addition, when the member is formed by a plurality of laminated translucent plates and when a heat-holding means such as air layer is formed between at least a single sheet of surface translucent plate and a sheet of translucent plate next to the surface one, the temperature of the surface of the member which was risen is held for a long time by placing the transparent electrode such as tin oxide at the surface layer.

The above-described method is particularly effective for preventing fogging on mirrors and windowpanes in lavatory and bathroom where large amount of water vapor likely occur.

[0278]

It is preferable that, when dry air is further supplied to the surface of translucent member of Figs. 1 through 4, the humidity on the surface of the member decreases, thus making the water vapor molecules more difficult to attach.

A method for supplying dry air is, for example, use of an air conditioner.

The method is particularly effective for preventing fogging of inside surface of glass walls of automobiles, trains, and airplanes, and for preventing fogging of mirrors in houses.

[0279]

The means for irradiating light may use room lamp and solar ray. A preferable means for irradiating light is the one containing high ultraviolet luminance against the surface of the member for enhancing the effect to sustain and recover the hydrophilicity.

To do this, in the case of mirror, for example, it is preferable to locate a means to irradiate light containing ultraviolet against the whole periphery or a part of the periphery of the mirror.

In that case, when a skirt-shaped rim is positioned to enclose the means to irradiate light containing ultraviolet light, the luminance of ultraviolet light irradiated against the surface of the mirror is increased, and the light emitted from the means to irradiate containing ultraviolet light is prevented from directly entering into eyes.

As an alternative method, the member may be the one structured by laminating plurality of translucent plates, and the means to irradiate light containing ultraviolet may be located between the members. In that case, the means to irradiate light containing ultraviolet light is preferably a flat light source. With the configuration, the luminance of ultraviolet light irradiate against the surface of the mirror is increased. In that case, it is preferable to turn off the light source during using time. Even if, however, the light source is accidentally turned off, the operator is safe because ultraviolet light is absorbed by the photocatalyst in the surface layer.

As an alternative method, the means to irradiate light containing ultraviolet light is positioned as a flat light source to cover rear surface of the glass before fabricating the mirror, then silver mirror treatment is given to fabricate the antifogging mirror. Also in that case, the configuration increases the luminance of ultraviolet light irradiated against the surface of the mirror. In that case, it is preferable to turn off the light source during using

time. Even if, however, the light source is accidentally turned off, the operator is safe because ultraviolet light is absorbed by the photocatalyst in the surface layer.

[0280]

Long term antifogging effect and effect of recovery of hydrophilicity of the above-described members are described below referring to the experimental examples.

(Experimental example 1)

Tetraethoxysilane, 36% hydrochloric acid, pure water, and ethanol were mixed together at respective weight ratio of 6 : 2 : 6 : 86. The mixture was allowed to stand for 1 hr, then the mixture was applied onto the surface of soda glass by the flow coating method to obtain an intermediate member P.

Titanium tetraethoxide and ethanol were mixed at respective weight ratio of 1 : 9, to which 36% hydrochloric acid was further added at 10 wt.% to the titanium tetraethoxide to obtain a coating liquid. The coating liquid was applied onto the surface of the intermediate member P in dry air by the flow coating method. The coating weight per application was adjusted to 45 g-titanium oxide per square centimeter.

After then, the applied intermediate member P was dried in dry air for a period of from 1 to 10 min, followed by firing at 500℃ to obtain a specimen A.

The surface of the specimen A was applied by 1 wt.% silver lactate aqueous solution. The light of 20W BLB fluorescent lamp was irradiated onto the surface of A from a distance of 20 cm to obtain a specimen B.

[0281]

For the specimen A, the specimen B, and for reference materials of soda glass and intermediate member P, the evaluation was conducted on antifogging property, contact angle with water, and anti-abrasion characteristic.

As for the antifogging property, an as-prepared specimen and a specimen after irradiated by BLB fluorescent lamp for 1 month were treated by breathing method to provide fog on the surface thereof, then the presence/absence of water droplet on the surface was checked under a microscope.

For the contact angle with water, an as-prepared specimen and a specimen after irradiated by BLB fluorescent lamp for 1 month were determined for the angle of contact using a contact angle meter.

Regarding the anti-abrasion characteristic, a slide abrasion was given to the surface of each specimen using a plastics eraser, then the change of appearance was observed. The criterion of the evaluation on the anti-abrasion characteristic is given below.

◎: No change occurred after 40 cycles of traverse.

○: Flaw appeared and the surface layer was separated after traversing cycles of 10 or more and less than 40.

△: Flaw appeared and the surface layer was separated after traversing cycles of 5 or more and less than 10.

×: Flaw appeared and the surface layer was separated after less than 5 cycles of traverse.

[0282]

Table 1

[0283]

Since the soda glass substrate has a hydrophobic property giving 50 degrees of contact angle with water, the soda glass after prepared the specimen showed the generation of water droplets. To the contrary, the specimens A and B, and the intermediate member P did not show water droplet on the surface because they have a small contact angle with water, less than about 1 degree and they are sufficiently hydrophilicized. After irradiating BLB fluorescent lamp for 1 month, the soda glass substrate and the intermediate member P were hydrophobicized to a significant degree, giving 53 degrees and 49 degrees of contact angle with water, respectively, and showed generated water droplets. On the specimens A and B, however, the contact angle with water was small, less than about 1 degree for both of them, and the hydrophilicity was confirmed to sustain and no water droplet was observed.

[0284]

Effect of recovery of hydrophilicity was determined for the specimens A and B, and for the specimen C which was prepared by the following procedure.

The steps for preparing the specimen C are; washing the soda lime glass with 0.1 mol/l hydrochloric acid on a warm water bath; mixing titanium tetraethoxide and ethanol at a respective weight ratio of 1 : 9; further adding 36% hydrochloric acid to the mixture at a rate of 10 wt.% to the titanium tetraethoxide to prepare a coating solution; applying thus prepared coating solution onto the surface of the soda lime glass in dry air using the flow coating method. The coating weight per application was 45

ug-titanium oxide per square centimeter. After then, the applied coating was dried in dry air for a period of from 1 to 10 min, followed by firing at 500℃ to obtain the specimen.

Determination of the effect of recovery of hydrophilicity was conducted by wiping the surface of the specimen with alcohol to improve the contact angle of the surface of the specimen with water. Then, BLB irradiation with 0.5 mW/cm^2 of ultraviolet output was given to the surface of the specimen, and the change in contact angle with water with time was determined.

[0285]

The result is shown in Fig. 6.

For all the specimens A through C, the contact angle was reduced with time. Compared with the specimen C, however, the specimens A and B drastically rapidly reduced the contact angle, and became zero within 30 min.

[0286]

Next, anti-bacterial property was determined for the specimen B and the soda glass substrate.

Evaluation of anti-bacterial property was carried out using W3110 strain of Escherichia coli.

A glass plate (100 x 100) on which 0.15 ml of bacteria liquid (10000 - 50000 CFU) was dropwise added was attached to the uppermost surface of each of the above-described specimens which were preliminarily sterilized by 70% ethanol. White light (3500 lux) was irradiated to the specimen for 30 min. The bacteria liquid was wiped off using a sterilized gauze, which was then recovered into 10 ml of physiological salt solution. Thus the survival rate

was determined to use as the index of evaluation. The criteria of index are listed below.

◎: Less than 10% of survival rate of Escherichia coli.

○: Ten percent or more and less than 30% of survival rate of Escherichia coli.

△: Thirty percent or more and less than 70% of survival rate of Escherichia coli.

×: Seventy percent or more of survival rate of Escherichia coli.

The evaluation of soda glass substrate was (x, and the sample B showed (◎) of evaluation.

[0287]

(Experimental example 2)

A solution of siloxane resin containing a curing agent was applied onto a transparent acrylic plastics substrate (10 cm square). The substrate was treated by heat at 150℃ to prepare an intermediate member S.

A liquid was prepared from a nitric acid reptisation type suspension of titanium oxide sol having 0.01 μm of average suspended particle size, added by solid titanium oxide at a respective rate of 5 wt.%, 10 wt.%, 50 wt.%, and 80 wt.% to the sum of the weight of the solid titanium oxide and the siloxane resin, to prepare individual sample liquids, which liquid was then diluted by propanol followed by adding a curing agent. Thus prepared liquid was applied to the intermediate member S, which member was then treated by heat at 150℃ to obtain an intermediate member T.

A BLB lamp light (0.5 mW/cm^2) was irradiated against the intermediate member T for a specified time to obtain the

specimen.

For each of the specimen and the intermediate member S, evaluation was given on the relation between the lamp irradiation time and the degree of hydrophilicization, the antifogging property, the hydrophilicity, and their sustaining and recovery effect, and the anti-abrasion property.

[0288]

Fig. 7 shows the relation between the lamp irradiation time and the degree of hydrophilicization when the ratio of solid titanium oxide in the surface layer to the siloxane resin in the surface layer is changed. For the intermediate member S, the contact angle with water showed no change. For the specimens contained 5 wt.%, 10 wt.%, 50 wt.%, and 80 wt.% of solid titanium oxide, however, irradiation within 200 hr decreased the contact angle with water to about 3 degrees. Also for the specimen contained 5 wt.% of solid titanium oxide, irradiation of lamp for 200 hr decreased the contact angle to about 10 degrees. Thus these specimens contained solid titanium oxide showed favorable hydrophilicity.

[0289]

Fig. 8 shows the result of evaluation on anti-abrasion property. For comparison, a specimen which formed the surface layer without adding siloxane resin was also evaluated. The result revealed that, if the rate of the solid titanium oxide in the surface layer is not exceeded 95 wt.% to the sum of the solid titanium oxide and the siloxane resin, the evaluation is (○), and if the rate is 90 wt.% or less, the evaluation is (◎).

[0290]

Antifogging property and hydrophilicity, and their sustaining and recovering effect were evaluated applying similar procedure with Experimental example 1 and using the specimen irradiated by lamp for 10 hr, and containing 50 wt.% of solid titanium oxide in the surface layer to the sum of the solid titanium oxide and the siloxane resin.

The result showed that the contact angle with was favorable, less than 3 degrees, at immediately after the irradiation and at 1 month has passed after the irradiation, which proved that the effect was sustained.

After the surface of specimen was wiped using alcohol to increase the contact angle of the surface with water, the surface was irradiated by BLB having 0.5 mW/cm^2 of ultraviolet light output to determine the change of contact angle with water with time. After about 1 hr of irradiation, the contact angle with water decreased from 30 degrees to 1 degree.

[0291]

[Effect of the Invention]

For a member, a long period of antifogging effect is ensured by providing a hydrophilic exposed surface and a means to sustain the hydrophilic exposed surface.

[Brief Description of the Drawings]

[Fig. 1]

Fig. 1 shows an example of the present invention.

[Fig. 2]

Fig. 2 shows another example of the present invention.

[Fig. 3]

Fig. 3 shows further example of the present invention.

[Fig. 4]

Fig. 4 shows still another example of the present invention.

[Fig. 5]

Fig. 5 shows an Auger spectroscopy profile of an intermediate member prepared in the course of manufacture of an antifogging translucent member according to the present invention. Fig. 5(a) shows the uppermost surface of a specimen. Fig. 5(b) shows the position of 20 nm below the uppermost surface of the specimen. Fig. 5(c) shows the position of 200 nm below the uppermost surface of the specimen.

[Fig. 6]

Fig. 6 shows an effect of recovery of hydrophilicity in an example of the present invention.

[Fig. 7]

Fig. 7 shows the relation between the lamp irradiation time and the degree of hydrophilicity in an example of the present invention.

[Fig. 8]

Fig. 8 shows the relation between the quantity of titanium oxide in the surface layer and the anti-abrasion property in an example of the present invention.

[Description of Reference Symbols]

1 ... film made of hydrophilic material

2 ... photocatalyst

3 ... substrate

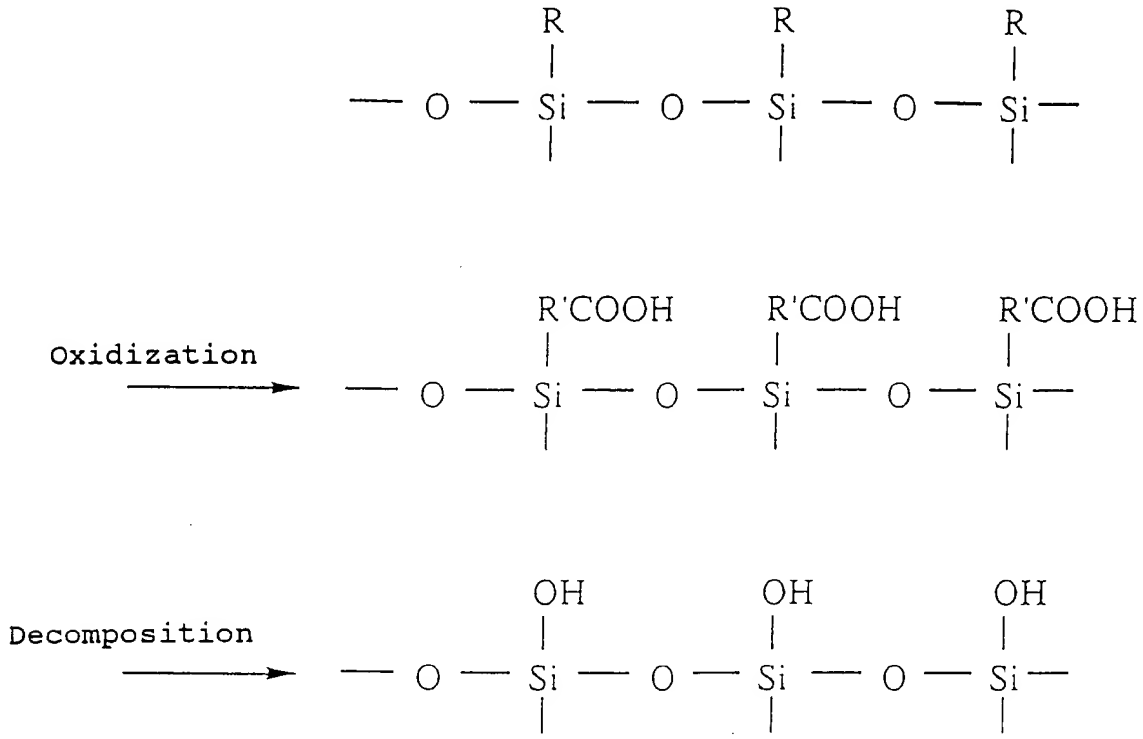
4 ... layer made of hydrophilic photocatalyst

5 ... non-photocatalytic hydrophilic material

6 ... hydrophilic photocatalyst

7 ... exposed surface made of non-photocatalytic hydrophilic material

[Formula 1]



[Table 1]

Specimen	After preparing specien			After 1 month has passed		
	Contact angle to water (°)	Antifogging property	Anti-abrasion property	Contact angle to water (°)	Antifogging property	Anti-abrasion property
Specimen A	< 1	Absence of water droplet	◎	< 1	Absence of water droplet	◎
Specimen B	< 1	Absence of water droplet	◎	< 3	Absence of water droplet	◎
Soda glass	50	Absence of water droplet	◎	53	Absence of water droplet	◎
Intermediate member P	< 1	Absence of water droplet	◎	49	Absence of water droplet	◎

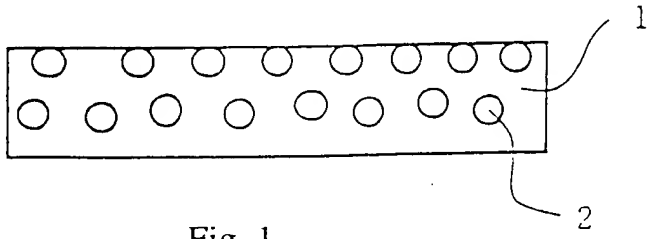


Fig. 1

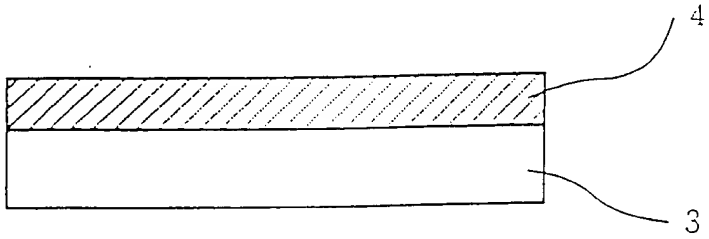


Fig. 2

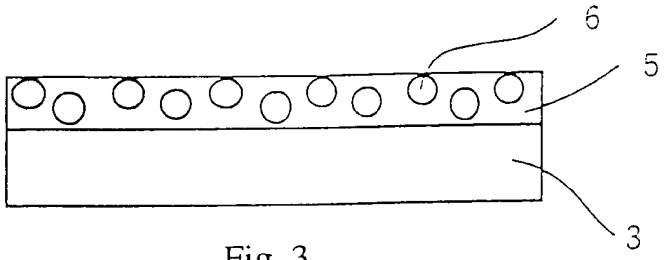


Fig. 3

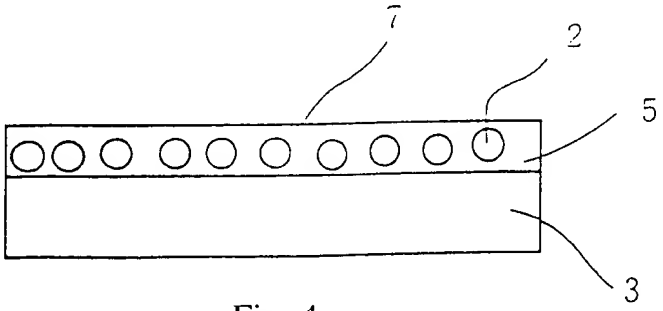


Fig. 4

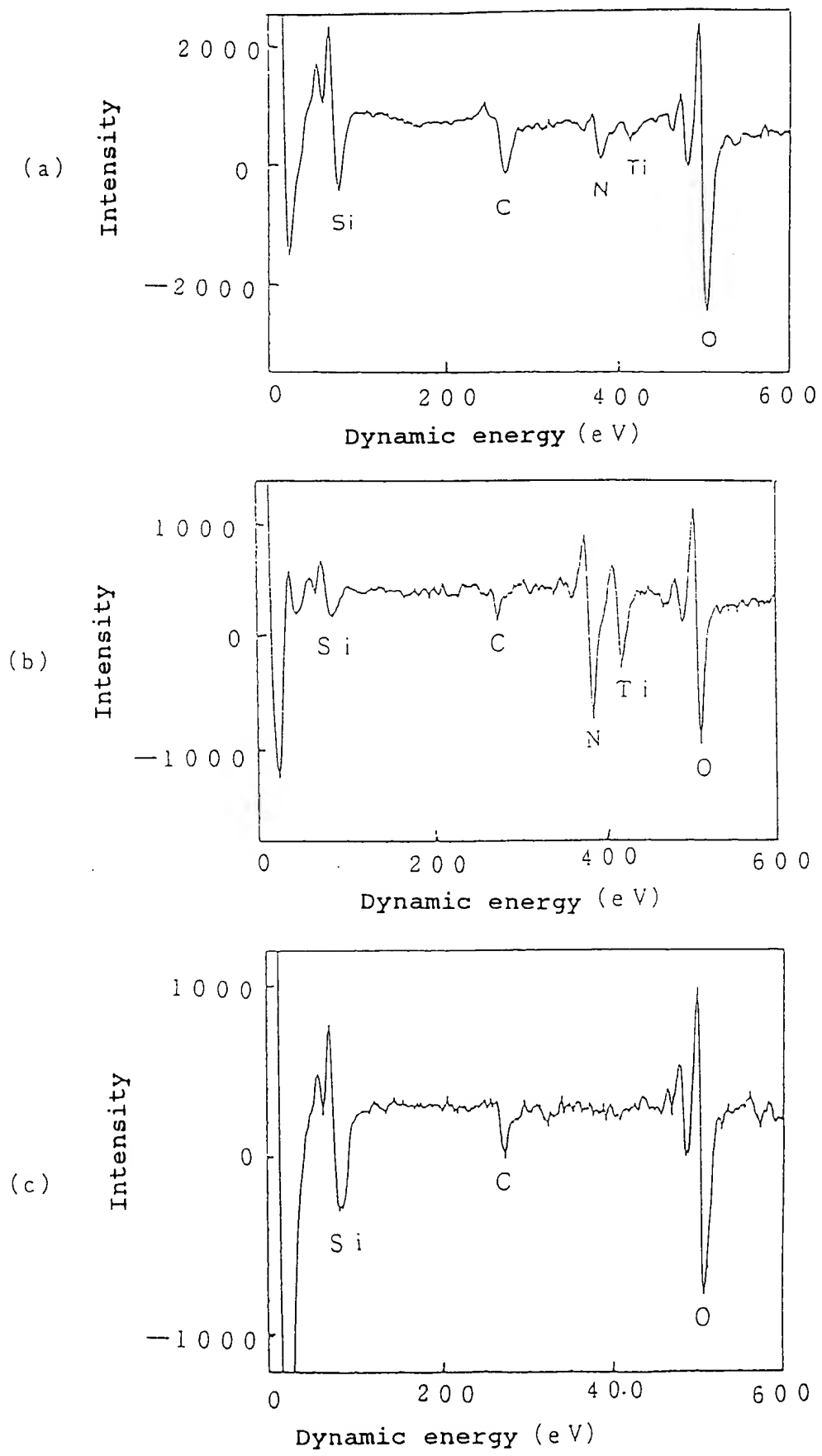

(a)
2000
0
−2000
Intensity
Si
C
N
Ti
O
0
200
400
600
Dynamic energy (eV)
(b)
1000
0
−1000
Intensity
Si
C
N
Ti
O
0
200
400
600
Dynamic energy (eV)
(c)
1000
0
−1000
Intensity
Si
C
O
0
200
400
600
Dynamic energy (eV)

Fig. 5

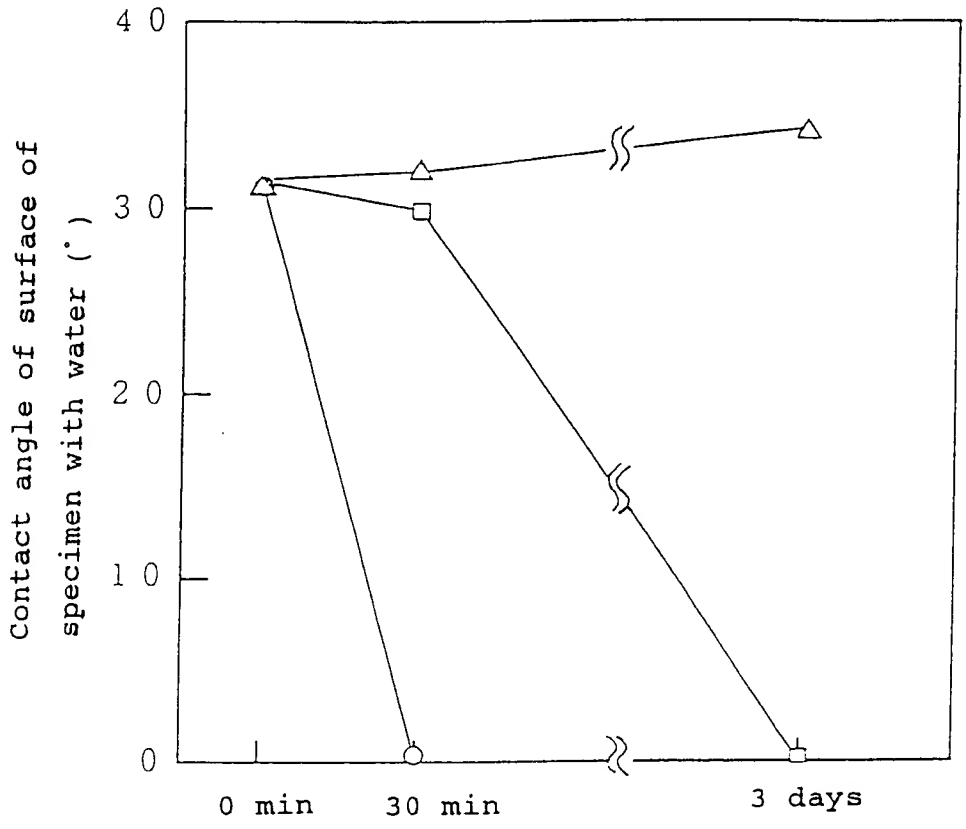

40
30
20
10
0
Contact angle of surface of specimen with water (°)
0 min
30 min
3 days
BLB irradiation time
○: Specimen A, Specimen B
□: Specimen C
△: Soda glass

Fig. 6

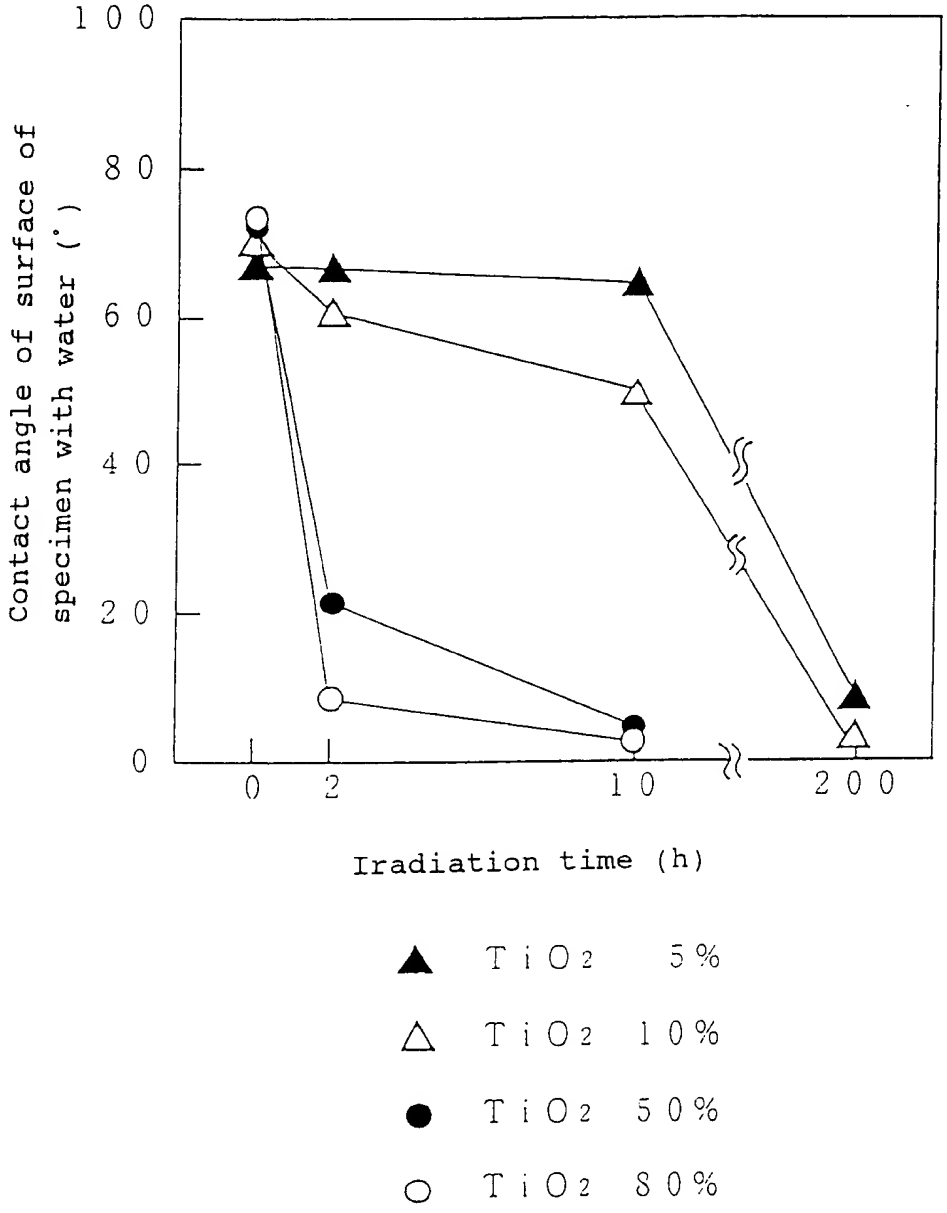

100
80
60
40
20
0
Contact angle of surface of specimen with water (°)
0
2
10
200
Iradiation time (h)
TiO2 5%
TiO2 10%
TiO2 50%
TiO2 80%

Fig. 7

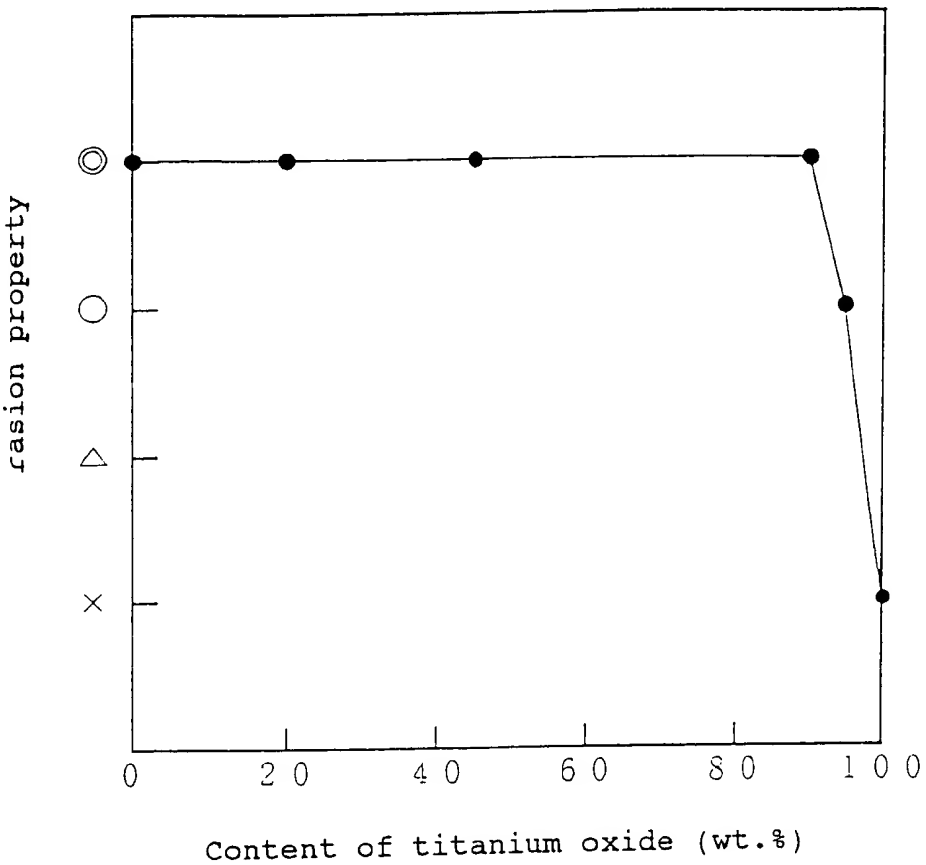

rasion property
◎
○
△
×
0
20
40
60
80
100
Content of titanium oxide (wt.%)

Fig. 8

Abstract

[Object]

To provide a translucent member having a long period of antifogging effect.

[Constituent]

An antifogging member comprising a hydrophilic exposed surface (5) and a means (6) to sustain the hydrophilic exposed surface.

[Selected Drawing]

Fig. 3